WEST INDIAN BULLETIN.

The Journal of the Imperial Department of Agriculture for the West Indies.

VOLUME I.

JULY 1899 — OCTOBER 1900.

ISSUED UNDER THE AUTHORITY

OF THE

COMMISSIONER OF AGRICULTURE

FOR THE WEST INDIES.

Barbados: Messrs. Bowen & Sons, Bridgetown.

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CONTENTS.

West Indian Bulletin

Vol. 1.] [No. 1.

INTRODUCTORY.

It is proposed to issue, in connection with the newly-created Imperial Department of Agriculture in the West Indies, an occasional publication containing notes of the operations of the Department and information respecting the best means for improving the cultivation and preparation of tropical produce.

The West India Royal Commissioners recognized "that communication between these Colonies is difficult and with the outside world it is both tedious and expensive. The persons engaged in cultivation suffer from this state of isolation, and are often without any information as to what is being done elsewhere. The cultivator of one product is often quite ignorant of the best means of cultivating any other, and does not know whether his soil and climate might be better adapted for something else. These remarks have special reference to the small cultivators, but they are not wholly inapplicable to persons interested in the larger estates."

It is hoped that, while the "West Indian Bulletin" will serve to diffuse information of immediate interest to all classes of people in the West Indies, it may be of service also, to those, in other parts of the world, whose commercial enterprises are associated with these Colonies.

Although it is proposed to deal fully with scientific problems and afford assistance in the improvement of sugar-cane cultivation and manufacture and of other

established industries, the Bulletin will form an important means whereby the people, generally, will be educated in sound and scientific methods for cultivating the soil and in the growth and preparation of economic products suitable to the varied circumstances of these Colonies. In addition, it is proposed to issue Leaflets containing hints, expressed in simple and clear language, on the treatment of the soil and plants, suitable for distribution amongst peasant proprietors after lectures and demonstrations by agricultural instructors. Copies of these Leaflets will, in addition, be supplied for distribution to magistrates, medical and other Government officers, the clergy and all persons having influence in country districts.

A few years ago in the whole of the British West Indies there were only two botanical institutions, (Jamaica and Trinidad). Now there are twelve. This development is one of the strongest proofs that these Colonies are gradually recognizing the value of systematic scientific organization for increasing their natural resources and affords great encouragement as regards the future.

It is only necessary to add that, while the "West Indian Bulletin" will follow on the lines so successfully adopted in the "Kew Bulletin" and more recently in the useful Bulletins issued by the Botanical Departments in Jamaica and Trinidad, it is hoped it may be possible to add a few new features especially in the number of the illustrations. The Bulletin will be available for distribution from all the Botanic Stations and will be supplied free to residents in the West Indies who will communicate their Name and Addresses to the Officers in charge of the Stations.

D. MORRIS,
Commissioner of Agriculture
for the West Indies.

Barbados,
1st July, 1899.

Imperial Department of Agriculture.

In consequence of the depressed condition of the West India Colonies a Royal Commission was appointed on the 22nd December 1896, as published in the following announcement:—

The Queen has been pleased to appoint General Sir Henry Wylie Norman, G.C.B., G.C.M.G., C.I.E. (Chairman); Sir Edward Grey, Bart., M.P., and Sir David Barbour, K.C.S.I., to be commissioners to inquire into the conditions and prospects of the West India sugar-growing Colonies, and Sidney Olivier, Esq., B.A., to be their Secretary; Daniel Morris, Esq., D.Sc., C.M.G., Assistant Director of the Royal Gardens, Kew, will accompany the Commission as Expert Adviser in botanical and agricultural questions.

The terms of the reference to the Commission were as follows :—

"To inquire into the condition and prospects of the colonies of Jamaica, British Guiana, Trinidad and Tobago, Barbados, Grenada, St. Vincent, St. Lucia, and the Leeward Islands, and of the sugar industry in those colonies, and of the labouring classes there, and especially whether the sugar industry is in danger of extinction in such colonies or any of them, and what is the amount of capital at present invested in it; whether the present depression is due wholly or in part to mismanagement, imperfect processes, absentee ownership, or any other causes independently of the competition of sugar produced under the bounty system, and whether the removal of such causes would be a sufficient remedy for the said depression. Whether in the event of the abandonment of sugar cultivation there are other industries which could be prosecuted with success, and which would find adequate employment for the population: and what would be the probable result of a complete failure of the sugar industry on the condition of the labouring classes, both West Indian and East Indian, and on the revenue of those Colonies, and whether any deficiency of revenue caused by the extinction of the sugar industry could be met by economies in the administration without imperial aid."

After taking evidence in London the Royal Commissioners left for the West Indies in R.M.S. "Don" on the 13th January 1897. They arrived at British Guiana on the 27th of the same month. They left British Guiana in H.M.S. "Talbot" on the 6th February, and visited, in the order named, the Colonies of Grenada, St. Vincent, Barbados, Trinidad, Tobago, St. Lucia, Dominica, Montserrat, Antigua, St. Kitts-Nevis and Jamaica. From Jamaica the Royal Commissioners left in H.M.S. "Talbot" for New York on the 14th April and arrived at Liverpool on the 1st May. There were held in all forty-five formal meetings

*Correspondence relating to the Sugar Industry in the West Indies. Presented to Parliament by command of Her Majesty, February 1897. London: Eyre and Spottiswoode [C. 8359]. Price 1s.

and three hundred and eighty witnesses of all classes and occupations were examined.

The Royal Commissioners presented their Report to the Queen on the 25th August 1897.*

The recommendations contained in this Report have already been fully discussed in the West Indies. One of the results of the West India Royal Commission has been the creation for these Colonies of an Imperial Department of Agriculture.

The Right Honourable the Secretary of State for the Colonies (Mr. Chamberlain) in the course of the debate in the House of Commons on August 2nd, 1898, when introducing the supplementary estimate providing for the creation of the Department, spoke as follows:—

"The recommendations of the Commission in this regard were twofold. In the first instance they suggested that a special Department [of Agriculture] should be established dealing with all questions of economic plants and botanic stations in all the islands—we propose to adopt that suggestion and that this establishment should be placed under the direction of Dr. Morris, Assistant Director at Kew, who is marked out, as I think any one who knows anything of Kew will admit, by special qualifications for an important position of this kind. Not only has he all the scientific and other knowledge in the possession of the authorities at Kew, but also special acquaintance with the West Indies, and, if those other industries are to be successful, there is no one more capable of doing it than Dr. Morris. In order to carry out this scheme, which we owe entirely to the Royal Commission—because, except in detail, I know no way of improving on their recommendation—we ask for a grant of £4,500, all the money we can spend during the present financial year. But we estimate that the annual charge will be £17,500. . . . . As regards the grants which we ask from the Imperial exchequer, I have to point out that it is absolutely impossible for the Colonies to bear the cost under the present circumstances. We hope they may be in the future self-supporting, but at present it is absolutely impossible for them to do anything for themselves. If these grants were thrown on the revenue of the Colonies, the only result would be that their deficit would be increased, and we should have to ask for an increased grant in aid instead of a grant in aid for communication, agriculture, and technical instruction. The advantage of taking the whole matter into our hands is that we shall have it under our control, and we shall not be hampered by local jealousies, and shall be able to introduce something like a general scheme, which would be impossible if local Legislatures

* Report of the West India Royal Commission with Subsidiary Report by D. Morris Esq., D. Sc., C.M.G., (Appendix A.) and Statistical Tables and Diagrams and a map (Appendix B.), also, Appendix C. Volumes I, II, III, and IV. Presented to Parliament by Command of Her Majesty. London: Eyre and Spottiswoode, 1897. Price 11s. 1d.

in each case had to be consulted, and local jealousies were brought into play. I regard the whole of this cost as being an expenditure intended to relieve the British Government of future charges. The object is to assist the West Indian Colonies in every possible way."

Sir Edward Grey, M. P. (one of the West India Royal Commissioners), said: Part of the vote is a grant in aid of an Agricultural Department, and I am exceedingly glad to hear that Dr. Morris is to be in charge of this department. He will bring to the discharge of his duties a knowledge of tropical produce, the possibilities and conditions of the cultivation of that produce, which I do not think can be surpassed by any one. He will bring to the administration of the department the greatest ability, energy, enterprise and devotion to work. His knowledge and assistance in reference to the prospects of the islands we visited were of the greatest value to the Commission, and I am sure his work at the head of the department will be of the highest value to the islands, and will be of increasing value year by year.

The following is a copy of an Official letter addressed by the Secretary of State to the Governors of all the West Indian Colonies (including the Bahamas and British Honduras) respecting the organization and working of the Imperial Department of Agriculture:—

Downing Street,
6th September, 1898.

Sir,—You will have learnt from public sources of information that Her Majesty's Government have decided that, in accordance with certain of the recommendations of the West India Royal Commission, a Department of Agriculture shall be established in the West Indies. The cost of this Department for a period of ten years will be provided from Imperial funds, and grants will also be made in aid of the Public Revenues of Trinidad and Tobago (for the benefit of the latter Island), British Guiana, Barbados, the Windward Islands, and the Leeward Islands, to provide for or to assist in the maintenance of Agricultural and Botanical Establishments, Industrial Schools, or other kindred purposes, as has been done for the last half of the current financial year under Sub-Head S 3 of the Supplementary Estimate laid before Parliament last Session, of which a copy is enclosed.

2. The headquarters of the Imperial Department of Agriculture in the West Indies will be at Barbados and the staff will consist of a Commissioner of Agriculture, a Travelling Superintendent and a Clerk. Dr. D. Morris, C.M.G., Assistant Director of the Royal Gardens, Kew, has been appointed Commissioner of Agriculture and will take up his duties in Barbados early in October next. He will correspond directly with the Colonial Office upon all matters concerning the general work of the Department; on matters affecting Colonial

Establishments and expenditure he will correspond with the several Colonial Governments through the Colonial Secretaries.

3. He should be consulted on all Botanic and Agricultural questions and on all matters affecting the organization, duties and expenditure of the Botanic Departments or other kindred institututions wherever their cost is to be reimbursed out of the Imperial Grant in Aid; and his services and those of his asssistants should be made use of in every way possible with a view to the development of the resources of the Colonies.

4. The general principles on which the work of the Department will be organized are indicated in the additional note appended to the Report of the Royal Commission pp. 145—7 and in the enclosed extracts from letters addressed to this Department by Dr. Morris, containing suggestions for the consideration of Colonial Governments. In these suggestions I entirely concur, and I would especially call your attention to the proposal for arranging a Conference of the chief chemical and botanical officers in the West Indies at an early date with a view to the prosecution of a policy of co-operative effort.

JAMAICA.

Although no direct provision is made under this scheme for financial assistance to Jamaica, it is hoped that the operations of this Department and the advice of the Commissioner may be of advantage to the Director of Public Gardens and Plantations in that Colony, and that representatives of Jamaica will take part in the proposed Conference.

TRINIDAD.

The West India Royal Commissioners recommended the establishment of a Botanic Station at Tobago in subordination to the Trinidad Botanic Station. Provision is included under Sub-head S 3 for an expenditure not exceeding £250 on this service as from 1st October next up to the 31st of March next, and provision not exceeding £500 will be made the following year. The details of expenditure within this limit and the appointment of the establishment will be settled by the Colonial Government subject to the approval of the Secretary of State, the Commissioner of Agriculture advising you on these points. You will find Dr. Morris' preliminary suggestions in the enclosed extract.

BRITISH GUIANA.

The series of experiments in sugar cane cultivation which has been pursued in the Colony under your Government has been of interest and value in the past, and it is proposed to render assistance in continuing and extending these experiments in connection with the work of the new Department as from 1st October next. In the meantime I enclose for your consideration a further extract from a letter from Dr. Morris with regard to preliminary measures upon which I shall be glad if you will communicate with him at an early date, and will for the present only add that £500 out of the Grant in S 3 will probably be available for sugar cane experiments in British Guiana.

BARBADOS.

The series of experiments in sugar cane cultivation which has been pursued in the Colony under your Government has been of interest and value in the past and it is proposed to render assistance in continuing and extending these experiments in connection with the work of the new department as from 1st October next. In the meantime I enclose for your consideration a further extract from a letter from Dr. Morris with regard to preliminary measures upon which I shall be glad if you will communicate with him at an early date, and will for the present only add that £625 will probably be available out of the Grant in S 3 for sugar cane experiments in Barbados.

LEEWARD ISLANDS.

Provision is included under Sub-head S 3 to meet an expenditure not exceeding £435, for the maintenance and extension of the Botanic Gardens at Antigua, as from 1st October to the 31st March next, and for £430 to cover the maintenance of the Gardens at St. Kitts-Nevis. For the purposes of the Botanic Station and for Agricultural instructors in Dominica, a sum of £500 is included to cover the expenses for the same period. It is intended at the same time to organize an Industrial School in that Presidency upon the lines indicated in the extract from Dr. Morris' letter quoted above, and for this purpose an additional £250 is included, and the use of a building can no doubt be arranged for by the Local Government. The question of any arrangements to be made with regard to Montserrat and the Virgin Islands should be discussed in detail with the Commissioner upon his arrival in the West Indies, but it is contemplated that an outlay not exceeding £250 may be incurred in Montserrat for similar services in the same period.

WINDWARD ISLANDS.

5. Provision is included in Sub-head S 3 of the Imperial Grant to meet expenditure not exceeding £365 for the maintenance of the Grenada Botanic Station as from 1st October to the 31st March next, and not exceeding £375 in each case to cover the cost of the Stations at St. Lucia and St. Vincent for the same period, and, subject to what is stated below, provision will be made in future years for the upkeep of these Stations at the same rate or thereabouts.

6. It will be understood that these establishments as well as any additions to them which may hereafter be made, will continue to be borne upon the local Estimates, and a Grant in Aid from the Imperial Exchequer will be made to meet the expense of them in cases where the local revenue is inadequate. The officials at present appointed and to be appointed as part of the new establishment will be members of the public service of the Colony, and will be subject for purposes of discipline to the control of the Governor.

7. In the case of Dominica and St. Vincent the Commissioner has recommended that measures should be at once

taken to commence fruit culture and has submitted preliminary suggestions which I recommend to your careful consideration.

8. A vote should be submitted to the local Legislature of St. Vincent for the small expenditure needed for purchase of bananas recommended. Votes should likewise be introduced where necessary to meet the possible expenditure in Grenada, St. Lucia, and St. Vincent for the current year as above indicated, so soon as the Department commences its work. Such votes, however, should, unless specific instructions are given, only be introduced after communication with the Commissioner of Agriculture.

9. As the Parliamentary Grant is taken in the form of a Grant in Aid, Provision for all such expenditure as may be subsequently re-imbursed out of the Grant in Aid from the Imperial Exchequer, should in the first instance be made in the Colonial Estimates. For purposes of Audit in this country the Certificate of the Commissioner will be required that the money in question has been expended as contemplated by Parliament; and for this purpose it will be necessary that he should be regularly furnished with detailed Accounts of the Colonial Expenditure on such service.

10. No provision has been made for the purchase of land or for buildings which must be provided by the local Governments so far as may be necessary.

11. I have to add that, as a highly technical Officer will be stationed in the West Indies, it will be desirable that such questions as have hitherto been referred to the Director of Kew Gardens should in future be dealt with by the Commissioner of Agriculture, who will decide in each case whether it is necessary or desirable to refer them to this country.

I have, etc.,

(Sgd.) FRED. GRAHAM,
(For the Secretary of State.)

Governor

....

&c., &c.

AGRICULTURAL CONFERENCE, 1899.

THE FIRST AGRICULTURAL CONFERENCE held in the West Indies met in the Chamber of the House of Assembly, Barbados, on Saturday morning, the 7th January, 1899. The President was Dr. D. MORRIS, C. M. G., M. A., D. Sc., F. L. S., the Commissioner of the Imperial Department of Agriculture for the West Indies. The following Representatives appointed by their respective Governments attended the Conference :—

JAMAICA.

The Director of Public Gardens and Plantations (WILLIAM FAWCETT, Esq., B.Sc., F.L.S.).

The Government and Agricultural Chemist (FRANCIS WATTS, Esq., F.I.C., F.C.S.).

The Principal of University College, Kingston (Rev. WILLIAM SIMMS, M.A.).

BRITISH GUIANA.

The Government Analyst and Professor of Chemistry (Professor J. B. HARRISON, M.A., F.I.C., F.C.S.).

The Principal of Queen's College (J. A. POTBURY, Esq., M.A.)

Agricultural and Technical Chemist, Plantation Diamond (WILLIAM DOUGLAS, Esq., F.I.C., F.C.S.).

Agricultural and Technical Chemist to the New Colonial Company, Ltd. (FREDERIC J. SCARD, Esq., F.C.S.).

TRINIDAD.

The Superintendent of the Royal Botanic Gardens (J. H. HART, Esq., F.L.S.).

Government Analyst and Professor of Chemistry (Professor P. CARMODY, F.I.C., F.C.S.).

The Inspector of Schools (R. GERVASE BUSHE, Esq., M.A.).

The Principal of Queen's Royal College (W. BURSLEM, Esq., M.A.).

The Principal of the College of the Immaculate Conception (Rev W. CAROLL).

THE WINDWARD ISLANDS.

The Curator, Botanic Station, Grenada (W. E. BROADWAY, Esq.)

The Curator, Botanic Station, St. Vincent (HENRY POWELL, Esq.).

The Curator, Botanic Station, St. Lucia (J. C. MOORE, Esq.)

THE LEEWARD ISLANDS.

Dr. H. A. ALFORD NICHOLLS, C.M.G., M.D., F.L.S., etc., Author of "Tropical Agriculture."

The Curator, Botanic Station, Dominica (JOSEPH JONES, Esq.)

The Curator, Botanic Station, St. Kitts-Nevis (WILLIAM LUNT Esq).

BARBADOS.

The Island Professor of Chemistry in chemical charge of Sugar Cane Experiments (Professor J. P. D'ALBUQUERQUE, M.A. F.I.C., F.C.S.).

The Agricultural Superintendent of Sugar Cane Experiments (J. R. BOVELL, Esq., F.L.S , F.C.S.).

The Acting Chairman of the Education Board (The Honourable W. H. GREAVES, Q.C.).

The Principal of Codrington College (The Rev. Canon BINDLEY, M.A., B.D.).

The Head Master of Harrison College (HORACE DEIGHTON, Esq., M.A., F.R.A.S.).

The Inspector of Schools (Rev. J. E. REECE. M.A.).

Among those present at the opening ceremony were His Excellency, the Governor, Sir JAMES HAY, K.C.M.G.; Major-General FOWLER-BUTLER; The Chief Justice, (Sir CONRAD REEVES); The Colonial Secretary (Hon. RALPH WILLIAMS); Hon. Sir GEORGE PILE, President of the Legislative Council; His Honour F. J. CLARKE, Speaker of the House of Assembly; The Master in Chancery, (Hon. W. K. CHANDLER); Hon. THOMAS KERR, C.M.G.; Auditor General, (E. T. GRANNUM, Esq.); Colonial Treasurer, (JOHN S. HOWELL, Esq.); Hon. W. P. LEACOCK, M.L.C., The Chancellor of the Diocese, (FOSTER ALLEYNE, Esq); Very Revd. Dean PHILLIPS; Chairman of the Chamber of Commerce, (J. GARDINER AUSTIN, Esq.); President of the Barbados Agricultural Society; President of the Horticultural Society; C. T. COTTLE, Esq., M.C.P., and H. E. BOYLE, Esq.; Vice-Presidents of the Agricultural Society; Hon. E. B. COLVIN, M.L.C.; G. SEALY, Esq.; G. LAURIE PILE, Esq., M.C.P.; J. CHALLENOR LYNCH, Esq., M.C.P.; R. RADCLYFFE HALL, Esq., B.A., Assistant Professor of Chemistry; E. L. SKEETE, Esq.; W. A. HORNE, Esq. (Colonial Bank); Commander OWEN, R.N.R., Superintendent Royal Mail Company; W. T ARMSTRONG, Esq.; S. J. FRASER, Esq. The following officers of the Imperial Department of Agriculture were present:—Mr. WHITFIELD SMITH, Travelling Superintendent, and Mr. WALTER FARRELL, Secretary to the Commissioner of Agriculture.

The Representatives were received in the Chamber of the House of Assembly at 10:30 a. m., by His Excellency the GOVERNOR, who opened the Conference by the following speech :—

LADIES and GENTLEMEN:—I consider I am highly privileged in being asked by Dr. Morris to open the proceedings of this the first Agricultural Conference in the West Indies and am convinced that most valuable results must accrue from its deliberations. I do not think the importance of the scheme initiated by Dr. Morris can be overrated. And I fully endorse the remarks of the Director of the Royal Gardens at Kew on the subject. Mr. Thiselton-Dyer says: the suggestion for a Conference of the officers engaged in the work of assisting Agricultural enterprise in the West Indies is one of the most important steps that has ever been suggested for organizing the development of their material resources. Up to the present action in this direction has been confined to isolated and individual efforts, and no opportunity has been afforded to those interested to meet periodically to compare notes and discuss the various points of interest. This want, thanks to Dr. Morris, is now supplied; and in offering on behalf of Barbados a most hearty welcome to the Representatives of the sister Colonies, I beg to express a fervent hope that the subjects discussed and the information contributed in furtherance of efforts to advance the material prosperity of the West Indies may prove of permanent benefit. As it is important that business should begin as soon as possible the time at our disposal being limited, I will not detain you longer but will at once ask Dr. Morris kindly to proceed with his Presidential address :-

THE PRESIDENT'S ADDRESS.

Dr. MORRIS then rose and said :—This is the first Conference assembled in the West Indies to discuss the practical details of agricultural work. I re-echo the welcome just offered to you by Her Majesty's Representative in this Colony, and I trust that your visit and the important subjects that will be brought before you will be conducive to the welfare and prosperity of the communities among whom we live.

There is no doubt thatat the present time the circumstances of the West Indies generally are not in a satisfactory condition. In December 1896, a Royal Commission was appointed to examine into the present condition and future prosperity of the West Indies. This Commission made an exhaustive inquiry extending over several months, and in August, 1897, it presented a Report containing valuable suggestions calculated to restore and maintain the prosperity of these colonies and its inhabitants. It is generally admitted that the Royal Commissioners were men of exceptional ability and experience, and that their conclusions were entitled to be received as conveying a true and adequate account of the circumstances of the West Indies.

The recommendations of the Commission have since been adopted by Parliament, and a beginning has been made in

giving effect to them by the establishment of a Department of Agriculture for the West Indies. The duties of the Department are twofold: (1) to endeavour to restore the sugar industry to a condition in which it could be profitably carried on; (2) to encourage the establishment of other industries in such colonies as afford suitable conditions to supplement the staple industry.

The funds at the disposal of the Department up to the 31st March next, amount to £6,500. It is estimated that the annual provision afterward will be £17,500. As stated in the speech of the Secretary of State in the House of Commons in August last, this "must continue, if the experiment shows a prospect of success, until the colonies are once again placed in a self-supporting condition."

As you are aware, the duty of organising the Department of Agriculture in the West Indies has been entrusted by Her Majesty's Government to me, and I look forward with great interest to the work, and am prepared to devote all my time and energies to the important concerns committed to my charge. I ask, and I know I shall not ask in vain, for your cordial co-operation in the task of improving the Agricultural interests of the West Indies.

There has been a disposition in some quarters to represent the scheme of the Agricultural Department as a weak alternative to the demands of the sugar planters. As a friendly critic has pointed out: "It is nothing of the kind. On the contrary it is founded on a close and keen study of the needs of the Colonies, and is devised not only to improve the methods of sugar cultivation, but to promote that variety of industries, that independent cultivation of the soil, which is necessary if these communities are ever to become stable, well-ordered and flourishing."

THE SUGAR INDUSTRY.

The Agricultural Department is specially charged to assist the Sugar Industry wherever the conditions are favourable for its continuance. It is a cardinal point in the policy of the Department to prevent, if possible, a single acre of land now under canes from being thrown out of cultivation. Whether this will be practicable in every case will depend on circumstances, many of them beyond the control of the Department. Nevertheless, as far as the Department is concerned, it will discharge the important duties intrusted to it with fidelity and care. If its efforts are well supported and its recommendations fully carried out, there can be no doubt the sugar industry will eventually reach a more prosperous condition than at present. There are in the West Indies certain Colonies in which the cultivation of the sugar cane has continued for a long period to be the staple industry. These may be termed sugar Colonies. They are British Guiana, Trinidad in part, Barbados, Antigua and St. Kitts Nevis. The others, namely Jamaica, Grenada, St. Vincent, St. Lucia, Dominica, Montserrrat and the Virgin Islands, although at one time, and still to some extent, dependent on the sugar industry

have found themselves quite unable to withstand the keen competition of recent years. If they are to exist at all, they will have to depend on other industries than sugar.

The operations of the Department must, therefore, be so distributed as to give adequate assistance to each of these groups. The population to be supported is almost equally divided between them. In the interest of the people themselves it is, therefore, as important to give attention to the non-sugar Colonies as to the sugar Colonies.

Returning to the sugar Industry, apart from the operations of certain political and fiscal changes which cannot be discussed here, there is a very considerable amount of work to be done to assist the sugar planters; for instance, in enabling them to improve their methods and in reducing the cost of production. We must, I think, assume that if the production of sugar goes on steadily increasing everywhere. prices cannot increase to any appreciable extent.

With the wider areas placed under cultivation, and the energy displayed by many European nations, the tendency is for the price of all tropical produce to fall rather than to rise. In order, therefore, to meet this, there must be cheaper production; and cheaper production in the case of sugar demands the highest skill and knowledge in cultivation with the latest and best appliances in manufacture.

In every sugar-producing country great importance is attached to improving the quality of the particular plant yielding sugar. In European Countries, the amount of sugar yielded by the beet has been nearly doubled within a comparatively short period. Until within the last ten years, nothing had been done on similar lines to improve the quality of the sugar cane. This work was only possible when by a fortunate circumstance the power of the sugar cane to produce fertile seed was fully realized. This occurred almost simultaneously in the East and West Indies—in Java and Barbados. This island is, therefore, to be congratulated, no less than those personally connected with it, in having been among the first to grasp the practical bearing of this fact.

The point now is to utilize to the utmost the capabilities of the cane in this direction and endeavour to place it in an equally favourable position as the beet. The experiments so far carried on, though on a limited scale, have been most encouraging. We have results from Java, the Hawaiian islands and Louisiana, all confirming those obtained in the West Indies. I have recently cited those obtained in British Guiana. I would now draw attention to a seedling cane obtained in Barbados of a most promising character. [Dr. MORRIS here exhibited a bunch of fine canes that had previously been brought in and placed in the upper part of the Hall.] It was raised at Dodds Botanical Station and is known as Barbados, (or shortly) B. 147. I quote from a letter written by Mr. Bovell (who raised this cane) as follows:—"This cane has been under cultivation here for the past five years, and it has during that time given an average yield of nearly half a ton of available sugar per acre over the 'Caledonian

Queen' which comes next, and more than three-quarters of a ton more than the 'Bourbon'. All the planters who have tried it speak favourably of it, and I have no hesitation in recommending planters in the black soil districts to plant this year about a third of their estate with it."

Mr. Bovell adds the following comparative statement of the average results for five years obtained at Dodds with the Seedling Cane B. No. 147. and certain other canes usually cultivated in Barbados:—

Name of Cane.	Sucrose per Imperial Gallon lbs.	Glucose per Imperial Gallon lbs.	Average available Sugar per acre. lbs.	REMARKS
Seedling No. 147 ..	1·794	·114	7,190	
Caledonian Queen ...	1·980	·041	6,137	
Rappoe	1·922	·041	5,929	
Naga B.	1·937	·051	5,894	
Bourbon	1·775	·086	5,210	
White Transparent	1·801	·086	5,275	3 yrs. only

The best proof of the value attached to this cane is the keen demand which has arisen for it amongst the planters themselves.

Several fields of it exist in different parts of the island and it is reported as having actually yielded as high as three tons per acre. This year about 200 acres will be established on one group of estates. Further, in an island where new canes have hitherto been regarded with a certain amount of suspicion it is a promising sign that those in possession of B. 147. find it advantageous to sell canes in large quantities to their neighbours. One planter alone has disposed of over one million plants this season. The demand for this cane from the neighbouring Colonies is also considerable.

There are numerous other directions in which the Sugar Industry might be improved. It is proposed to undertake a series of experiments with various kinds of manures to find out the sorts best adapted to certain soils, and the period in regard to the age and condition of the canes at which they should be applied. Further, there is the treatment of the various insect and fungoid pests to which the sugar cane is subject. In previous years, the loss arising from these causes has been very considerable. This loss is largely preventable, and it will be the business of the Department to study the circumstances and advise the planters to the best of its ability.

At Barbados, the experiments in these directions have already

been started. Mr. Bovell has been placed in charge of the field work with the title of "Agricultural Superintendent of Sugar Cane Experiments," while Professor d'Albuquerque will be in charge of the chemical work. With the hearty co-operation of the proprietors of estates, I have pleasure in stating that there will be established four Principal or Central experimental Stations, and eight Local Stations for the improvement of the sugar cane in this island. The Central Stations will be devoted to raising seedlings and to carrying out their treatment in the early stages until they are accepted as distinctly improved varieties. They will also afford opportunity for carrying on several series of manurial experiments. The Local Stations will be entirely concerned in the practical and final testing under normal conditions of the best varieties and their adaptability as sugar producers in different soils and climates of the island. At the Local Stations the planters in each parish will have opportunities of observing the growth and habits of the selected canes treated like all the other canes on the estate, and of afterwards obtaining plants or tops for establishing their own plantations. The total area covered by these experimental stations will be about 130 acres. It is arranged that experiments on similar lines will be started at once at Antigua and St. Kitts. In regard to Trinidad, the experiments started by Mr. Hart will, it is hoped, be largely extended, while the chemical work will be undertaken by a competent officer. At Jamaica, where the experimental cultivation of canes introduced from other countries was started more than 20 years ago, and whence many varieties have been distributed to the neighbouring Colonies, it is anticipated that Messrs Fawcett and Watts will be able to take up experiments of a thoroughly useful character. I am unable to give information at present in regard to what is likely to be done in British Guiana. There is, however, before the Government of that Colony a proposal to provide funds, as advised by the Royal Commission, for continuing, on a large scale, the experiments which have already produced such good results.

The total amount so far proposed to be expended on the special sugar cane experiments in Barbados, British Guiana, Antigua, and St. Kitts-Nevis is £3,350. As all previous efforts in these islands have not cost more than about £350 annually, there is every hope that with the larger funds now available which provide for the entire service of several competent officers, the ultimate results of the experiments cannot fail to be of great assistance to the sugar industry.

I do not, however, disguise the fact that outside British Guiana and Trinidad, and to some extent, St. Lucia, whatever improvement may take place in regard to new varieties of the sugar cane, the application of manures, the treatment of disease and the reduction of expenses in cultivation, the sugar industry in the smaller islands will never be in a satisfactory condition so long as the processes of crushing the canes and manufacturing the sugar remain as at present.

We have in the report of the Royal Commission the most painful demonstration of the inadequacy of the methods now

in use. For instance, owing to defective treatment it is recorded (based on experiments extending over seven years) that there "is an average of over 2,000 pounds of sugar per acre left in the canes after crushing which is burnt in the megass." A large part of this could have been recovered by better machinery. At present in these islands it is said to require about 18 tons of canes to produce one ton of sugar. With the best machinery about 9 tons should be sufficient to produce a ton of sugar. There is according to reliable authority a further heavy loss in boiling the juice and in converting it into sugar. I quote the exact words:—"for every 100 pounds of crystallisable sugar contained in the juice, not more than an average of 75 pounds of ordinary muscovado sugar is now recovered."

Apart, therefore, from the loss incurred by imperfect crushing, the loss in actually manufacturing the sugar amounts to one-fourth of the total quantity produced. These statements appear to apply generally to the sugar industry as carried on in the smaller islands. As already stated, they do not apply to British Guiana and Trinidad, and to some localities in the island of St. Lucia. There, very efficient machinery and appliances are used, and any improvements in other directions should add to the advantages already existing. As you are aware, the remedy recommended by the Royal Commission to prevent such a loss in the smaller islands was the establishment of Central Factories. This subject, as you will notice, is down for discussion by the Conference this afternoon. I trust that the information which will be placed before us by those competent to speak on the subject, will lead to one or two experimental factories being established during the present year.

The time has evidently arrived when it is absolutely necessary for the planters to decide what the future of the Sugar Industry in these islands is to be. In commercial, as in natural life, the perpetual struggle for existence necessitates continual adjustment to new and fresh conditions. When this adjustment is wanting or imperfect, the industry, or being, is pushed aside and disappears. It is now imperative for the sugar planters to adapt themselves to the conditions of their environment, or they become "unfit." In other words, they will be unable to hold their own and they and their industry must disappear.

With your permission I would touch upon one or two other points. Rule of thumb methods, wherever existing, must be abandoned, and with them must be abandoned the crude and empirical notions in regard to agricultural subjects that have long since been discarded by our rivals amongst the intelligent communities of Europe and America. A simplification of methods for working sugar estates as well as for disposing of the produce (already adopted in some instances) is also necessary. This should tend to reduce the costs of management and, further, should enable the planters to obtain all estate supplies at reasonable prices.

Formerly, when the price of sugar was high, it was possible for the industry to bear charges that are now quite impossible.

Times have changed and simple and more direct methods, all culminating in reducing expenses, must now be adopted, otherwise West Indian sugar will have no chance of competing successfully in the markets of the world.

OTHER INDUSTRIES.

In discussing the steps necessary to place the West Indies, generally in a more satisfactory condition, the Royal Commissioners drew special attention to the need for expanding the number and extent of other industries. Their words, which I quote in full, are as follow: –

"The recommendations involving expenditure by the "mother country which we have considered it our duty to "make, are based primarily on the present and prospective "depression of the sugar industry in the West Indies, but they "are of such a nature that they should, in our opinion, be "carried out even if the sugar industry were restored temporarily "to a condition of prosperity. It is never satisfactory for "any country to be entirely dependent upon one industry. "Such a position is, from the very nature of the case, more or "less precarious, and must, in the case of the West Indies, "result in a preponderating influence in one direction tending "to restrict development in other ways.

"The general statement regarding the danger of depending "on a single industry applies with very special force to the "dependence of the West Indian Colonies upon the sugar "industry, for the cultivation of sugar collects together a "larger number of people upon the land than can be employed "or supported in the same area by any other form of cultivation. "In addition to this, it also unfits the people, or at any "rate gives them no training, for the management or cultivation "of the soil for any other purpose than that of growing sugar "cane. The failure, therefore, of a sugar estate not only leaves "destitute a larger number of labourers than can be supported "upon the land in other ways, but leaves them also without "either the knowledge, skill, or habits requisite for making "a good use of the land.

"Whilst, therefore, the vital importance of the sugar "industry to the present prosperity of nearly all the Colonies "is beyond dispute, we wish to observe that, so long as they "remain dependent upon sugar, their position can never be "sound or secure. It has become a commonplace criticism "to remark upon the perpetual recurrence of crises in the "West Indian Colonies, and we submit that the repeated "recurrence of such crises, as well as the fact that the present "crisis is more ominous than any of the previous ones, "illustrates the danger to which we have referred, and adds "much force to our recommendations for the adoption of "special measures to facilitate the introduction of other "industries."

The coast lands in the West Indies have been under cultivation in many instances for more [than] a hundred years. In several districts large tracts have been abandoned

as useless, and the casual visitor seeing these only is under the impression that the West Indies "are played out." A reference to the Report of the Royal Commission will show, what few realize, that so far from being exhausted, the total area of cultivable land not beneficially occupied at present, amounts to more than 22 million acres. Leaving out British Guiana, which is only partially explored, and confining our attention only to the Islands, viz., Trinidad, the Windward Islands, Barbados, the Leeward Islands and Jamaica, we find even within this smaller area, that leaving out swamps, rocky and other useless land, and allowing for land to be reserved in forest, there are still over 2 million acres suitable for bearing crops. The actual area under cultivation is only about a million acres. Practically, therefore, only one-third of the cultivable land in the West Indian islands is at present utilized. These facts appear in the following table compiled from the official returns supplied to the Royal Commission:—

Place.	Area in Acres.	Area now Cultivated.	Area of cultivable land not beneficially occupied.
		Acres.	Acres.
British Guiana	65,836,000	325,000	20,000,000
Trinidad and Tobago ...	1,193,313	310,000	550,000
Windward Islands .	328,122	95,000	135,000
Barbados	106,470	90,000	10,000
Leeward Islands	390,840	100,000	150,000
Jamaica	2,692,480	693,674	1,500,000
Total	70,547,225	1,613,674	22,345,000

Taking the colonies as a whole, we find the area now under cultivation is only a little over 2 per cent. of the total area, and only a little over 7 per cent. of the estimated cultivable area.

From the consideration of the land, we now pass to the circumstances of the population. It is admitted that even in Sugar Colonies like British Guiana, only one-third of the total population is directly engaged in the industry. If we allow another third for those indirectly engaged and for Indians, we shall still have a third of the population contributing little or nothing to the exports of the Colony. In St. Vincent, St. Lucia, Dominica, Montserrat, Antigua, and St. Kitts-Nevis and Jamaica, there are thousands of people whose labour at present is devoted to raising casual food crops. They thus destroy land that with suitable treatment should yield valuable crops for export.

The object of starting other industries is first of all to

realize to the best advantage the extensive tracts of unused lands in these islands; and, secondly, to find remunerative employment for people who are now almost without the means of subsistence. Other industries are, therefore, essential.

In taking up this work I fully realize the difficulties of the situation. I am also sensible of the enormous amount of labour involved, and the slow and tedious character of the operations necessary to produce results at all commensurate with the cost of the undertaking. I have, however, a close acquaintance with the circumstances of these Colonies. I have carefully studied their resources and I am not unused to deal with what is termed the "labour difficulty." In spite of these I retain, after an experience of twenty years, a strong faith in the future of these Colonies, and I believe that, rightly guided and assisted in these days of their adversity, they will realize the destiny designed for them by nature, and they will yet become happy and prosperous communities.

It is needless to enter into details. The work immediately at hand is to give attention to the sugar industry. When efforts are fully started in that direction, then I hope within a short time to devote the energies of the Department and the funds at my command in building up those other industries which the exceptionally able men on the Royal Commission regarded as essential to the permanent well-being of the West Indies.

BOTANICAL INSTITUTIONS.

The Royal Commissioners stated that the botanical institutions in the West Indies have rendered considerable assistance in improving agricultural industries, and "they are capable of being made increasingly useful in this respect." Twenty years ago there were only three such institutions in existence. Now, owing to the organization of the small establishments known as Botanic Stations, there are thirteen of these institutions. The results at the latter, "though not yet extensive, have been of a distinctly promising character." As the Colonies of Jamaica, Trinidad and British Guiana were regarded by the Royal Commission as in a position to maintain their own Botanical Establishments, no grants-in-aid in their case have been voted by Parliament. As regards the Botanic Stations, it is proposed to place them under the direct control of this Department, and the charge of maintaining them is transferred to Imperial Funds. The Botanic Stations so transferred, are those at Tobago, Grenada, St. Vincent, Barbados, St. Lucia, Dominica, Monserrat, Antigua, and St Kitts-Nevis. Amongst the duties to be discharged by the Botanic Stations, the Royal Commissioners indicated the following:—"They are to devote themselves in a systematic manner to the work of introducing, propagating and distributing all the promising economic plants of the tropics. They are to initiate the experimental cultivation of new or little known plants, and assist in the efforts made in the larger colonies to secure improved varieties of the sugar cane. They are to act as centres for diffusing accurate information, and as training institutions

for the practical teaching of tropical agriculture, also as the headquarters from which agricultural instructors would be sent, to give lectures and demonstrations bearing upon the selection of land for tropical economic plants, their suitable cultivation, and the best methods for curing and packing the produce."

AGRICULTURAL INSTRUCTORS.

A considerable experience has shown that it is not sufficient to provide Botanic Gardens and Experimental Stations to influence the large body of cultivators in the West Indies. They must be reached in a more direct and effective manner. The first attempt to employ travelling instructors was made on my recommendation in Jamaica in 1891. Two Cacao instructors were appointed by Sir Henry Blake, and the results since that time have fully justified the use of this method of assisting in the development of rural industries. Great care is necessary in selecting men possessing the necessary qualifications. In Dominica, St. Lucia and Grenada, it would be an advantage for them also to be able to speak the local *patois*. It is important to arrange beforehand with the leading personages in each district, so that the people are prepared to receive the Instructor and made thoroughly acquainted with the objects of his visit. A public meeting is useful as a first step, to be followed by visits to gardens and cultivated areas in the neighbourhood where the Instructor is able to give practical demonstration in the right methods of preparing the soil, in draining and manuring, and in putting out the plants in a neat and suitable manner. Later, he would show how the plants are to be cared for and pruned, and ultimately he would give a regular course of instruction in curing and preparing produce for export. These details carefully instilled into the minds of the people would be part of the general training necessary to direct the raw labour material of these islands into the right channels. I am absolutely convinced of the efficiency of the system, and it would not be difficult to mention several striking instances of the success that has attended it when the right men are employed and they are placed under favourable circumstances for carrying out the duties intrusted to them. It is proposed to attach an Agricultural Instructor to each of the Botanic Stations, and an officer with a similar training will have charge of the cultural work at the Agricultural Schools. Where it is not possible to attach an Instructor to the Botanic Station, arrangements will be made to allow the Instructor's duty, in part at least, to be undertaken by the Curator, leaving the garden meanwhile in charge of a competent foreman. In addition, Instructors, or experts, with special experience in budding and pruning fruit trees, curing tobacco, bee-keeping, selecting and packing fruit for export, will be employed to spend a month or two in each island and thus distribute practical knowledge over a wider area. For some years to come, the peripatetic instructors must be relied upon to carry out a large share of the training necessary amongst the adult portion of the community. In spite of the disadvantages incidental to their isolated position, these people are not slow to follow the

advice given them once they are convinced of its practical utility and of its direct bearing upon their future welfare.

AGRICULTURAL EXHIBITIONS.

Agricultural Shows or Exhibitions are not new in the West Indies. They have been held for some years in the larger Colonies. They are practically unknown in the smaller Colonies. The purely educational side of these Exhibitions, especially in regard to small cultivators, has not been so fully recognised as it should be. The prizes are in many cases given for produce possessing intrinsically little or no merit. It is often badly prepared and presented in a slovenly and uninviting condition. Such prizes are calculated to do more harm than good, as they encourage the people in unskilful and careless habits which destroy any chance of their obtaining remunerative prices for their produce. The work of substituting careful and intelligent methods for those already so prevalent in the West Indies, will be a long and tedious task. It is, however, of so important a character that it must be dealt with. Possibly, the best way to start a better system in handling and marketing produce, is to offer several prizes at Agricultural Shows, but award them only in cases where the articles are presented in a thoroughly-satisfactory condition. The Department might exhibit similar articles, especially those intended for export, as object-lessons and arrange for some of its officers to be present to explain exactly what is necessary in order to reach a high standard of merit.

It is understood that the prizes offered by the Department are in aid of local efforts and not to supersede them. Further, the Department will bring together implements of field and garden husbandry and explain the construction and mode of working of suitable machinery for cleaning and curing produce. It will also exhibit cases skilfully packed with fruit and other produce ready for shipment.

It has been arranged that preliminary exhibitions will be held shortly at St. Lucia, Dominica and Montserrat.

BULLETINS, HANDBOOKS AND LEAFLETS.

The Royal Commissioners stated that "in the West Indies "persons engaged in cultivation suffer from isolation and "are often without any information as to what is being done "elsewhere." In addition to the employment of travelling instructors it is proposed to meet the difficulties of isolation by preparing and distributing bulletins, handbooks and leaflets affording information on subjects of general interest. The principal publication of the Department will be the "West Indian Bulletin." This will probably be issued at the end of this month, and will contain amongst other matter the proceedings of this Conference. The handbooks will contain hints and directions in simple language on the cultivation of certain crops such as Coffee, Cacao, Oranges, Pineapples, Bananas, Ginger, Vanilla, etc. The handbooks will be stitched in canvas covers and form a series similar to those issued in England and the United States. The leaflets will be of a more modest

character and will contain information expressed in simple and clear language suitable for distribution after addresses and demonstrations given to small cultivators by the Agricultural Instructors. These leaflets will also be supplied free to magistrates, medical and revenue officers, the clergy, police officers, and all having influence, or coming into contact, with the peasantry. Both the handbooks and leaflets will be regularly supplied to schools, and the teachers will be encouraged to use them in dictation lessons and take an interest in diffusing the information contained in them amongst the people of the district.

AGRICULTURAL TEACHING IN PRIMARY SCHOOLS.

In all agricultural communities the need of the hour is the education of the rising generation in the knowledge how to obtain from the soil those products for which there is a good demand in the markets of the world. Ignorance and ineptitude can never produce successful results. The prevailing practice in the West Indies is to take everything out of the land and abandon it immediately afterwards. This is a vicious and destructive system; but to suddenly change the habits of centuries is impossible. We must take the children and gradually teach them other ways. At least, the principles of sound agricultural methods must be taught in the elementary schools. Large sums are being spent in these Colonies on general education. The total quoted in the Report of the Royal Commission for the year 1896 was £180,000. It is admitted that "the efforts made on general education have been largely successful." In some colonies steps have already been taken to teach agriculture as a part of elementary education. The chief difficulty is the want of knowledge on the part of the teachers. It is hoped that the Agricultural Department, as suggested by the Royal Commissioners, "will be in a position to render valuable assistance" in this direction. With the co-operation of the central educational authorities in each colony, the teachers will be given a course of instruction in the principles of Agriculture. They will also be taught how to impart the knowledge thus obtained to their pupils in a series of object lessons. They will further be supplied with a school reader containing agricultural information in simple and plain language. This will form the basis of all the theoretical and practical teaching required for the first few years in elementary schools. Great hopes are based on the educational value of school gardens where the teachers and children will carry out practically operations suggested by the lessons taught in school. In England, the Educational Department recently referred to school gardens as follows:—"We fully recognise the improvement which a thorough knowledge of cottage gardening may effect in the condition of the working classes in agricultural districts; but as a school subject its teaching also serves a general educational purpose." Following the example set by the Education Department in Jamaica, it is proposed to make small grants in aid in two classes: (A) to schools in which the theory of Agriculture is satisfactorily taught; and (B) a slightly increased grant in cases where, in addition to the

teaching of the theory of Agriculture, school gardens or experimental plots are maintained by the efforts of the teachers and scholars.

The amount of the grant proposed for each school in class A would be from £1 to £3; in class B from £2 to £5; depending in each case on the number of children who reach a satisfactory standard of attainments. For the first year or two the total amount of these grants would necessarily be very small as the chief outlay would consist of expenses incurred in giving instruction to and in training the teachers.

AGRICULTURAL SCHOOLS.

The Royal Commissioners recommended that "a system of training in agricultural occupation was much needed" in the West Indies. It was suggested that "some at least of the Botanic Stations should have agricultural schools attached to them where the best means of cultivating tropical plants would be taught." It is proposed to carry out this valuable suggestion. Provision has been made to establish an Agricultural School immediately at Dominica, and as soon as the necessary land has been obtained, similar schools will be started at St. Vincent, St. Lucia and St. Kitts-Nevis. These schools are not to be Reformatories, and will not deal with criminals. This would defeat the object in view. The more suitable plan for obtaining pupils would be to admit, preferably from the country districts, orphans and destitute children over nine years of age, or those voluntarily placed at the schools by their parents or guardians. The order for their admission will require to be signed before a magistrate, and provide that the child remain at the school without molestation of any kind for a period of not less than five years. It is hoped by means of these Agricultural Schools to train a certain number of the children of respectable black people in sound agricultural methods. They will, first of all, be employed in raising their own food and will be accustomed to neat, intelligent and active methods of carrying on various operations of garden and field husbandry. Further, they will be carefully taught to handle tools, how to raise and prune fruit trees, the best means for getting rid of fungoid and insect pests, and how to bud and graft. The boys thus trained should be most useful afterwards in diffusing practical knowledge of this kind amongst their own people.

TEACHING SCIENTIFIC AGRICULTURE IN THE HIGHER SCHOOLS AND COLLEGES.

On this important subject a paper is to be read before the Conference by the Rev. William Simms who has given considerable attention to it. He has also visited the United States and Canada with the view of studying the methods there adopted. It is hoped from the paper itself and from the discussion that will follow, it may be possible to suggest a plan for at least starting the teaching of scientific Agriculture in the Colleges in the West Indies.

So far, little or nothing has been attempted in that

direction. In consequence, the students attending the higher Educational institutions turn their attention to the learned professions or to Government clerkships. Both these are now overcrowded, while the better paid appointments connected with scientific Agriculture, are filled from outside. We must endeavour to make Agriculture a popular and remunerative career for young men in the West Indies. To do this would be an effective means of generally increasing the resources of the colonies. It is understood that the training in Agriculture given in European countries is not suited to men who are destined for tropical planting. Such men are always better taught amid the special circumstances of the tropics.

The Department is prepared to offer grants to enable certain institutions to employ teachers in agricultural science, and possibly provide a number of scholarships for the most promising pupils. The Heads of these Institutions with whom I have conferred are thoroughly sympathetic in this direction. I, therefore, anticipate as one of the results of this Conference, that it will be possible to prepare a scheme for the teaching of agricultural science that will meet with the approval of the Imperial Government.

FUNGOID AND INSECT PESTS.

The injury done to food crops and fruit trees by fungoid and insect pests, is very considerable. The discouragement thus met with by those anxious to follow a better system of cultivation is no doubt responsible for the little progress that has hitherto been made in this direction. Usually, the small cultivators regard a disease in their crop as a fatalism, and make little or no effort to deal with it. They also leave the diseased crops on the land, which, in the case of fungoid disease, becomes infected with spores, and so the crops of succeeding seasons are also injured or destroyed. I estimate that the total loss to crops from preventable diseases in the West Indies amounts to several thousand pounds yearly. Mr. Fawcett will bring forward some suggestions on this subject before the Conference on Monday afternoon.

NEW STEAMSHIP SERVICES.

As directly associated with the work of the Imperial Department of Agriculture, I may mention that tenders were invited in London, in September last, for four new steamer services for the West Indies. Service A. is intended to provide a fortnightly service between all the islands from St. Kitts southward as far as Trinidad. The object of this service, in accordance with the recommendations of the Royal Commission, is to afford with the existing Royal Mail Service, a regular weekly service between the islands. Service B. is intended to be a fortnightly service between Trinidad, British Guiana, Barbados and Canada. This, it is hoped, will encourage trade in Sugar and other products between the West India Colonies specified above and the Dominion of Canada. Service C. provides for a fortnightly fruit-steamer service between St. Vincent, Dominica, and the United States or

Canada. The Steamers are to be specially fitted for the carriage of fruit and the Contractors are to undertake to purchase fruit at fixed rates. If circumstances require it, it has been suggested that this service be modified so as to provide fruit steamers between St. Vincent, Dominica and the United Kingdom. Service D. is intended to supply a direct tri-weekly fruit service between a port or ports in Jamaica and a port in the United Kingdom.

Dr. H. A ALFORD NICHOLLS, C.M.G. (Leeward Islands): I rise to move that the thanks of the Conference be given Dr. Morris for the able, interesting, and extremely instructive address that has just been delivered by him. Dr. Morris has mentioned that his address will be printed and placed in the hands of the members of the Conference, but that is not sufficient. I am satisfied that the whole public of the British West Indies are looking forward with keen interest to the utterances of the President of the most important Conference that has ever been held in the common interest of these Colonies. I beg, therefore, to move further that the address be printed, and that it be made to form part of the Report of the Proceedings of this Conference for publication and distribution throughout the West Indies.

The Honourable W. H. GREAVES, Q.C. (Barbados): I have much pleasure in seconding the vote of thanks moved to Dr. Morris, and the motion that the address be printed as part of the Official Report of the Proceedings of this Conference for distribution. I have had the pleasure of meeting Dr. Morris on official business during the past three or four weeks and I may remark that I was struck by the keen interest with which he has developed matters connected with his Department. I firmly believe that with Dr. Morris at the helm, the West Indian Ship of State will come forth out of the troublous waters and eventually reach a haven in safety. With his energy and ability, and the keen interest that he takes in the work of his Department, and also with the co-operation of the gentlemen I see around the table—most of whose faces are unknown to me, but whose names are very well known—I feel that if they give Dr. Morris that support which I am sure they will, recollecting that the West Indies are simply so many atoms of a vast whole, the success of his undertaking is assured.

The PRESIDENT: I am extremely obliged for the kind remarks that have fallen from the two speakers with regard to my address. I shall have pleasure in including it as a part of the Proceedings of the Conference. It is now proposed to enter at once upon the programme, copies of which have already been handed you. It will be seen that it is proposed this morning to devote the whole of our time to questions affecting the sugar-cane industry. I had hoped to have induced Professor Harrison to read a short Paper on the further work to be undertaken to improve the sugar cane in the West Indies; but, unfortunately we cannot have that pleasure. I will, therefore, call upon Professor d'Albuquerque to read his paper on "Manurial Experiments connected with the Sugar Cane."

SUGAR CANE MANURIAL EXPERIMENTS.

[By Professor J. P. D'ALBUQUERQUE.]

Mr. President—At your request I have committed to paper a few points for the purpose of introducing the subject of sugar cane manurial experiments for discussion. I understand that your object in desiring that this should be one of the subjects discussed at this Conference is to promote an exchange of views amongst practical experimenters, a possible settlement of any differences of opinion which may exist upon the best way of practically carrying out such experiments, and the affording of help to any that are newly entering upon this field of enquiry—through an interchange of ideas amongst workers who have devoted considerable time and thought to an important matter connected with West Indian Agriculture.

I confess to feeling some diffidence in opening this dicussion in the presence of one or two chemists who have worked at it so much longer than I have; and I should have been better contented to leave the matter in the hands of my friend and predecessor Professor Harrison, of British Guiana, whose work, carried on in conjunction with Mr. Jenman, both on seedling canes and on cane manure, must command the admiration of every student of science who has occasion to take up these interesting subjects, and form a model for every present and future worker.

I was requested to read a paper upon manurial experiments to occupy some 15 minutes in reading; but the lines that such researches have taken during recent years and their results, have been very excellently summarised by Professor Harrison in a paper read comparatively recently before the British Guiana Agricultural Society, and a paper worthy of reading in the presence of so many distinguished West Indian Botanists and Chemists already familiar with the subject, would have required much more time in its compilation than I could spare during the few busy days since I was apprised of the exact subject which I was asked to introduce to the Conference. I have, therefore, elected to confine myself to a few practical, and perhaps somewhat technical, details which have recently presented themselves to me afresh in starting some new series of experiments, and upon which I should be benefited by hearing the views of other West Indian workers who may favour us with their opinion upon some of the points raised and bring up others which are omitted in my remarks. I naturally look at the subject primarily from the view of Barbados which is the only Colony of which I have agricultural experience; other workers present will know how far methods require modification to meet the conditions of their own colonies.

Put very briefly, the heads which I touch upon are,—

(*a*.) the choice of locality,
(*b*.) size and number of plots,
(*c*.) variety of cane to be used,
(*d*.) methods of applying manures,
(*e*.) the selection of cane samples for crushing,

(*f.*) juice and megass samples for analysis,

(*g.*) the recording of results and the calculation of gain and loss.

I take it that wherever the soils and rainfall of a colony present sufficiently marked differences, it is desirable that a locality offering a typical specimen of each should be separately experimented upon. In every case the field chosen should be as uniform as possible in all respects and having selected such a field, (*b.*) the size of the plots will be the next matter to settle. Practical planters, including those that take a keen interest in agricultural experiments, are generally inclined to place little faith in results obtained on very small areas and consider that no result is worth much unless some acres have been under each separate test. Actual experimenters also, have in some cases tried to overcome the invariable differences of fertility occurring in even small fields by the use of comparatively large plots of say an acre on the apparent assumption that the differences of fertility from one part to another of such an area will neutralise one another and give a mean correct result. But when this method is adopted these differences of fertility are necessarily unknown quantities, and it is impossible to be certain when added up that these differences do not preponderate greatly in one direction. It seems to me that this method involves working in the dark, and that the uncertainties are by no means eliminated by duplicate or triplicate plots. I think the use of several *small* plots of each kind preferable and that the difficulties arising from variable fertility are most satisfactorily dealt with by the method of control plots employed by Harrison and Jenman. By this method an attempt (and it seems to me a very successful attempt) is made to ascertain what the relative variation of fertility actually is, permitting the comparison of the yield of each plot of a series with the mean of the yields of the no-manure plots calculated as 100: and this is the clearest method of exhibiting such results with which I am acquainted. No doubt an advantage attached to the use of a few large plots is the possibility of crushing the whole plot and taking a sample from all the juice, a procedure impossible with a large number of small plots where the frequent stoppages to an estate mill would cause too great a delay to the work of both the estate and factory. On the other hand, it has been shown to be possible to select a small sample of canes which will represent a plot with a sufficient degree of accuracy, and we have the great desirability of a large number of plots, if any large number of questions are to be answered within a reasonable time. Moreover, the loss which results from a non-manured small plot, or an inadequately manured small plot, both of which are a necessary feature of manurial experiments, is reduced to a minimum. When a large number of small plots is employed, the crushing will necessarily be done in a small experimental mill and I suggested the use of an oil engine attached to such a mill in the future experiments to be carried on in Barbados. Such a mill will express some 65 to 70 per cent. of the cane as juice, and as a rule only a sample and not the whole plot will be actually crushed in the mill.

(c) Having selected the field and determined the size of the plot, the next question will be the variety of cane to plant. I think most of us will agree that all things considered some kind of Transparent cane will be best adopted for the purpose, as Transparent canes resist drought and fungus better than the Bourbon and ratoon where the Bourbon will not do so. Personally, for Barbados, I should favour the White Transparent, using the term to include both Caledonian Queen and Rappoe which are held by Barbados planters to present differences from the cane known here as "White Transparent."

I think that in practice it will be desirable for each experimenter of experience to decide for himself the most important of all points relating to such experiments, viz., what constituents and how much of each to use in his experimental manures and when to apply them to the various plots: these are matters which will be affected at all events to some extent by local conditions and by what has already been learnt from experiment in his own and other localities.

(d.) At Dodds the experimental manures are mixed together and applied without admixture with ashes or other diluent. If this is carefully done, I see no obvious advantage in making in Barbados any change in that respect. The quantity of mixed manure for a single stool is first weighed in the field and then measured from a spoon in front of the boy who is to apply it, the boy then puts the same number of spoons to each stool. In some manurial experiments which I carried out elsewhere, I also used the mixed or undiluted manures, which were measured out in tin pots made to hold the approximate quantity required and adjusted in the Laboratory by putting clay at the bottom till each delivered the exact amount The pots were, of course, marked to correspond with the bags and plots. In the Dodds experiments the trash is drawn from the stool, a shallow furrow made around it, forming a circle of about 3 or 4 feet diameter, the manure is placed uniformly in the furrow, rubbed into the surface soil and the trash then drawn back around the hole.

(e) In the reaping of the plots, an all-important consideration where only a part of the plot is actually crushed, is the taking of a correct sample. In the British Guiana experiments the whole plot is sampled down by the eye in the field to a representative sample of 6 canes, and from them by a somewhat laborious process the final sample of 4 to 6 lbs is obtained for the Laboratory mill. In recent years at Dodds we have found it convenient to crush 100 lbs. of canes taken from the scales where the whole of the plot is weighed. The British Guiana method has been shewn to be a correct one when worked with judgment and care: but the means at our disposal here will permit of 100 to 200 lbs. of canes being crushed in the mill, and under our local conditions of working we prefer as far as possible to render the sampling as mechanical a matter as possible. I have, therefore, suggested, in future, when the canes are counted off the scales that, say, one in every five should be thrown aside in a heap: this would be, say, 80 canes from a 40 stool plot and form the

first sample and would insure a thorough mixing of canes from the different parts of the plot. To diminish the size of this large sample it can be similarly taken up one cane at a time and one in every two to six thrown aside to form the representative sample of 200 or 100 lbs.

(f.) The sucrose, glucose, and specific gravity of the juice have always here been determined upon a fresh sample. I do not know of any satisfactory preservative of these constituents in juice. Salicylic acid and carbolic acid although allowing considerable inversion I find fairly suitable for preserving juice for ash analyses or nitrogen determination.

The sampling of megass for analysis has always presented great difficulties to me. When I first took part in the experiments here, I found it customary to take a bag sample of the megass at the mill and place the bags of megass upon the factory boilers immediately after sampling, and by raising them rapidly to a somewhat high temperature prevent fermentation. They were dried at this temperature, taken to the Laboratory, powdered, and the sugar etc. determined in the dried sample and calculated to the undried megass. Were it possible to insure that the bags were placed on a boiler kept constantly hot enough until the megass were dry, and to insure that the bags were not afterwards exposed to damp before bottling off in the Laboratory, the method would be a very satisfactory one, and in the hands of my predecessor it appears to have worked well. For some two or three seasons after I took part in the work I found remarkable differences in my results compared with his, and at last it became obvious that fermentation had taken place in some of my samples and I have never since been able to satisfy myself that the samples which are sent (every year) to the boiling-house all reach me in a satisfactory condition for a comparison to be made of their analyses. A powerful shredding machine might powder the fresh sample of megass sufficiently rapidly to admit of its being thoroughly mixed and a sample of workable size being taken for analysis before changes have taken place. This would seem to me to be the best method of dealing with megass wherever its analysis is desirable.

(*g*) The final point to mention is that of the method of recording and calculating some of the results. There seems to be a pretty general consensus of opinion as to what results should be recorded. At Dodds the rotten canes are weighed and returned separately.

It has generally been the custom for experimenters to calculate the gain or loss from a given manure application by comparing the calculated yields of sugar in the expressed juice. Harrison and Jenman in their recent experiment have preferred to calculate it from the value of incremental canes. Wherever a tightly-braced three-roller mill giving an extraction of 65 to 70 per cent. is employed, I suggest that the error from comparing the values of the yields of sugar in the expressed juice is not greater than that of taking the weight of the canes, assuming an average composition and therefore value per ton, and calculating from this basis.

DISCUSSION.

Professor HARRISON (British Guiana): Dr. Morris has asked me to say a few words in reference to this matter. Professor d'Albuquerque seems to have experienced some difficulty with regard to keeping megass by drying it. When I was here, although I was not satisfied with the general conditions, I kept it for twelve months and analysed it every month, and certainly it did not change then. It was the same at the end of the twelve months as at the beginning. I do not, however, think that analysing megass is of much importance. It was formerly done for the purpose of ascertaining whether the sugar cane was the plant which was described in text-books as containing 18 and 20 per cent of sugar. We found it did not. We found it contained about 13 or 14 per cent. That was why megass was analysed. Now, as we have proved satisfactorily what the contents of the sugar cane are, we do not require further analyses of the megass. It will be quite sufficient if we examine the juice. Professor d'Albuquerque also speaks of the difficulty in preserving the juice. I have found that corrosive sublimate will preserve the juice for a sufficient time to make accurate determination. It will not affect the specific gravity. That, I think, is the most satisfactory substance I know of to preserve the cane juice a sufficient length of time to allow of analysis. It is better, however, that it be analysed the moment it is expressed. In my Laboratory, we start in the morning at 8 o'clock and the whole work is finished between 11 and 12 o'clock, so that there is little time for changes to set in. With regard to manurial experiments there is not the slightest doubt that you must have a complete system of soil control. My experiments at present cover a small area, although there is a large number of plots. I have about 170 to 200 plots, and there are about 11 control plots distributed throughout the field. I thought at one time that these would be sufficient to determine the differences in the fertility of the soil, but I would be more satisfied if instead of 11 of these plots, I had 40 or 50. Our fields in Demerara are of a different nature to the fields in Barbados, and to a person not knowing much about soils, it would appear that on a limited area, say of 13 or 14 acres, every part would be exactly alike. When we tried it, we found that on a plot of even four acres it was different in different parts. We found that the difference in fertility in different parts was greater than the difference to be obtained from manurial experiments. That is the reason why manurial experiments over wide areas are as a rule, not very successful. It is almost impossible to get anywhere an acre of land in which each part of that acre is all the same. This is true not only of Barbados but of British Guiana where land to the ordinary eye would appear to be exactly the same in every part. With regard to varieties of canes used for manurial experiments, where it is proposed to carry on ratooning, the Bourbon is not a suitable cane for that purpose. It is better to experiment with selected seedling varieties. The principal point in the experiments is to ascertain the amount of nitrogen the canes will take up. We know already the amount of phosphates and potash to apply. It does not matter whether you apply too much potash or too much phosphates, but the

difficulty is with the nitrogen. This is the constituent on the correct application of which the crop immediately depends. I believe (although I am being told that in so believing I am believing what I ought not to believe) that, where you apply excessive quantities of nitrogenous manures, you are raising a crop which is excellently suited for fungus.

Mr. FRANCIS WATTS (Jamaica): I should like to pay my tribute of respect and admiration to those gentlemen who have been engaged professionally in the work of manurial experiments in the colony of Barbados. There is no part of the world where sugar cane is grown to-day, where the name of Professor Harrison is not known and held in the highest respect. In my own experiments and work connected with this subject, I have always and at all times received the fullest help and assistance from him, and I am quite sure that the same remark would apply to all those who have had to seek advice from him, either when he was resident in this colony, or since he has been at British Guiana. Professor Harrison says that when he first came here, he had the task of finding out what the sugar cane was. It was at that time an unknown quantity, and it is to Professor Harrison, largely, that we know and are able to state with reasonable certainty what the sugar cane is, and what can be got out of it. [Professor HARRISON: The credit of working that out is not due to me so much as to my predecessor, Mr. Francis.] That in no way detracts from the merits of his own hard work. I think it is very largely due to Professor Francis and Professor Harrison that we know what the sugar cane is, and I think it is largely due to the latter gentleman that we have now seedling canes. Perhaps Professor Harrison will again tell us that he did not discover the seedling cane, but I believe I am correct in stating that he was the first to make it a valuable adjunct in experimental work. With regard to the paper read by Professor d'Albuquerque, I do not know that there is much for me to add. I think that most persons who have done this kind of work have come to the conclusion that it is difficult to obtain suitable plots, to be used as control plots, and that we must have ample assistance if we are to deal with an enormous number of such plots. That megass can be analysed we know, but that it can be preserved readily and easily for experimental work, is quite another matter. My experience is that it is a difficult and precarious matter to preserve megass so that the analyses may be put forward by the chemist with confidence. With regard to preserving juice, I may say I have used carbolic acid, mentioned by the two previous speakers, and it has almost invariably given satisfaction. In those cases in which it did not give satisfaction, I think failure was due to the presence of an enzyme in the juice. There is a matter that came under my notice—namely, the peculiar behaviour of the sugar cane in its relation to phosphates. It was found in the early experiments at Barbados that in some cases the addition of phosphates to the manure applied actually reduced the yield of sugar. At Antigua, my experience was very similar, and it is an occurrence I am unable to explain. Perhaps those who have had wider experience may be able to explain the reason

There is no doubt that the main factor of cane manure is nitrogen, and to the practical man to whom it means pounds, shillings and pence, the correct management of nitrogen is an important factor in determining his profit or his loss. In considering the varieties of canes to be grown and the kind of fertilisers to be applied, there is no doubt that much thought must be given to the surroundings of the station, and the conditions of the colony. When the small station at Antigua was started, experiments were first of all made with the Bourbon cane. It was soon found that this cane was attacked by a variety of diseases which rendered it extremely unsuitable for cultivation. We lost a large proportion even with the greatest care. But other varieties of cane withstood, to a certain extent, the ravages of the diseases. That these other varieties would entirely withstand disease, was too much to hope, but that they could withstand them to a great extent is clear. No doubt, that is a factor which will differ in every colony according to the conditions under which the canes are grown and cultivated. The extreme importance of experimental station work requires that these matters should be carefully dealt with. It is admitted that experiments of this kind are perhaps less carried out in the colony which I have the honour to represent, than in some of the others, because of the preponderance of other products in relation to the sugar cane crop. But I have no doubt that in the near future and with the encouragement of the Imperial Department of Agriculture, we shall be able in Jamaica to add our quota to the amount of information which it is the duty and function of the Department to acquire and utilise. *

The PRESIDENT: I would like Professor Harrison to state the distance his Laboratory is from the experimental cane fields in Demerara; and whether it is advisable to have the experimental cane mill on the plots or at the Laboratory.

Professor HARRISON: The distance of most of the plots from the Laboratory is, I think, about two and a half miles. The canes are brought down at night, and the crushing and

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*[Professor d'Albuquerque has requested me to add the following note, as the discussion on his paper was closed without giving him an opportunity of replying to the points raised.—THE PRESIDENT.]

Note.—I have tried both corrosive sublimate and carbolic acid as preservatives of cane juice for analysis. The former somewhat obscures the determination of the glucose by Fehling or Soxhlet methods and the latter does not prevent inversion unless added to the limed juice; and if limed, the sample cannot be used for ash analysis. Possibly, as Mr. Watts has suggested, Ammonia solution could be substituted for lime with equally good effect and without interfering with the ash determination.

While I admit that megass analysis is not likely to be needed in *manurial* experiments, I cannot agree with Professor Harrison, if he means that megass analysis will never be required in any investigations connected with the sugar cane; and I think it highly desirable from the point of view of the sugar chemist that some reliable method should be found for taking samples for analysis. When once dried I have found, with Professor Harrison, that the bottled samples will keep indefinitely; but the difficulty in my case occurs before they get to the Laboratory in the drying process. Unless the bags are watched personally by the chemist as I understand Professor Harrison did watch them—it is exceedingly unlikely that those in charge of the boiling house, already fully occupied, can give them the attention necessary to insure such a preservation as can be relied upon by the chemist, and upon which published analyses can be based.—J.P.D'A.

analysis take place next morning. It is absolutely necessary to have the mill as near as possible to the Laboratory. I would like to mention what I have observed to be the action of superphosphates on canes. If the files of the *Agricultural Journal* of this colony be referred to, an extract will be found in one of them, giving an account of an experiment by Dr. Voelcker who found that the yield of turnips is decreased by an excessive dressing of superphosphates, so that the very manure which he says is necessary to give a good yield, if applied in excessive quantities, decreases the yield. It is exactly the same case with the sugar cane. The cause of the decrease in yield by an excessive dressing of superphosphates is put down by Dr. Voelcker to the acidity of the superphosphates, which act injuriously on the rootlets of the plant. Where, however, the application is a limited one, it is profitable.

The PRESIDENT: The action of superphosphates on turnips, is discussed in the *Kew Bulletin* (1895, pp. 129-132, with plate). It is possible that the action is not a direct chemical, but a physiological one. It is another illustration of the care that is necessary in the application of manures to crops. As our time is limited, I would suggest that we proceed to the next subject on the Agenda - a paper by Mr. Bovell, the Agricultural Superintendent of Sugar Cane Experiments in this island.

FIELD TREATMENT OF THE DISEASES OF THE SUGAR CANE IN THE WEST INDIES.

[BY J. R. BOVELL, F.L.S., F.C.S.]

The paper which I now have the honour to read deals briefly with the field treatment of the diseases of the sugar cane in the West Indies.

For nearly two centuries the sugar canes in the West Indies have at certain periods been subject to various animal and vegetable pests, for we find from Schomburgk's *History of Barbados*, that as far back as 1518 the island of Hispaniola, or Hayti, as it is now called, was almost abandoned in consequence of an ant, which in that and in the two succeeding years, overran the island devouring all vegetation. About 1760 they showed themselves in Barbados and caused such devastation that it was deliberated whether the island, formerly so flourishing, should not be deserted. In 1763 they were found in Martinique, and in 1770, in Grenada. So great was the destruction which they wrought, that in 1776 the Government of Martinique offered a reward of a million of their currency for a remedy against the plague: and the Legislature of Grenada, £20,000 for the same object, but all attempts to get rid of them proved unavailing, until the hurricane of 1780 effected what man had been unable to accomplish. In 1814 they again made their appearance in Barbados, but did not long continue to do much damage. From then on, until the latter half of the last decade, the canes in the West Indies seemed to have been singularly free from any pests, with the exception of the moth borer.

However, about that time fungoid diseases began to

show themselves amongst the canes, not only in Barbados and the other West Indian Islands, but in almost every sugar-producing country in the world.

At the present time the insect and fungoid pests known to be attacking the canes in the West Indies are :

(*a*). The Moth Borer—*Diatræa saccharalis.*

(*b*). The Rind Fungus—*Trichosphæria sacchari.*

(*c*). The Root Fungus—*Colletotrichum falcatum.*

(*d*). White Blight—One of the Dactylopieæ—probably *Dactylopius calceolariæ.*

(*e*). Black Blight. A disease apparently caused by the fungus growing on the excretion voided by *Dilphax saccharivora.*

The shot borer, *Xyleborus perforans*, and the lady-bird borer, *Sphenophorus sacchari*, are found on decaying canes, but so far the preponderance of evidence with regard to these tends to show that they are saprophytic, not parasitic. Consequently, we may for the purposes of this paper take no further notice of them.

Of the foregoing pests, the moth borer has been known for many years, and was first described by the Revd. Lansdown Guilding at St. Vincent in 1828.

According to Professor Comstock, the eggs are flat and circular, and about one-twenty-fifth of an inch in diameter, white when first deposited, and turning yellow as they approach the hatching point. The egg takes about nine days to hatch. On the larva leaving the egg it begins at once to bore into the cane, on which it feeds for about thirty days, when it assumes the pupa condition. The larva when full grown is about one and a quarter inches long. The chrysalis is of a light brown colour, about three-quarters of an inch in length, and a sixth of an inch in diameter. The general colour of the moth is grey. The hind wings of the female are lighter than the fore, and lighter than either pair of those of the male.

The attack of the moth borer is first noticed as soon as the canes are a couple of months old, when the centre unfolded leaves of the infected canes are seen to turn yellow and then to dry. At this stage on examining one of the stricken canes, the apical portion of the growing cane is found to have been eaten through by one or more of the larvæ. Later on when the canes get further advanced, the larva will bore into them, and complete its life history without killing the cane. The moth borer, not only of itself, causes considerable loss, but as its tunnels form easy places of entrance for the spores of the rind fungus, it is highly desirable that this pest should, as far as possible, be destroyed, and to this end the following recommendations are submitted for consideration.

(1) That all borer plants, *i.e.*, plants bored by the moth borer, should be rejected, for even if they are soaked in some disinfecting solution, it is not possible in every instance for this to penetrate the narrow channels containing the larvæ and

pupæ, owing to the debris and air contained therein.

(2) That all plants should be soaked for twelve hours in lime water containing one gallon of lime to a hundred gallons of water; or a dilute solution of Jeyes' fluid; or a solution of carbolic acid containing one pint of the acid to a hundred gallons of water—so that any adhering eggs or insects may be destroyed.

(3) That careful inspection of the growing canes be made periodically, and whenever the presence of the larvæ is noticed, by the appearance of what are locally known as "dead-hearts," that all canes so affected be cut out and burned. If the estate mill is at work they may, instead, be passed between the rollers and then thrown on the compost heaps.

(4) That as soon as practicable after a field is reaped, all dried and decaying canes be collected and burned, passing any that contain juice through the mill first.

(5) That at the time of the year when the moth borer is most prevalent, lighted lanterns be suspended over vessels containing some viscous liquid, such as molasses and water.

We now come to the Rind Fungus: *Trichosphæria sacchari*, and that phase of the same disease known as the Root Fungus, (*Colletotrichum falcatum*.) These would seem from various authorities to have existed for several years before they caused much loss—the rind form probably only as a saprophyte.

The root form appears from such evidence as can be obtained, to have existed in isolated spots of several fields on certain estates in St. John's parish, for some years before it commenced to spread rapidly.

However that may be, the undoubted fact remains that these two pests, whether different forms of the same parasite, or two distinct fungi, have of late attacked the Bourbon cane with such virulence in Barbados, as well as in several of the other West Indian colonies, that most planters have been obliged to discontinue growing it.

Unless careful examination of a cane is made, the attention is first called to the attacks of the rind fungus, by the outer leaves of the top assuming a yellowish tint, the colour gradually fading until they are quite dead. The leaves are gradually affected in succession toward the centre, until the whole top is dry, and the cane in a state of decay.

If on observing the outer leaves becoming dry, the cane is examined, it will usually be found to have on one or more of the internodes, midway up the stem, reddish-brown discolourations. On cutting through the rind at these discolourations, the underlying tissue is seen to be red or brown, with whitish spots. Microscopical examination of the affected tissue, reveals the fact, that the cells of these portions of the cane are

penetrated, and in many instances, almost filled with the hyphæ of a fungus. Later on, black eruptions are observed piercing the cuticle, and these under the microscope are seen to be composed of myriads of spores, cemented together with a mucilaginous substance.

The root fungus (*Colletotrichum falcatum*), said to be a form of *Trichosphæria sacchari*, although this is denied by Went, is first noticed about the month of June, when the canes attacked seem to cease growing, the plants dwindle down, fresh shoots are sent up, which in turn waste away, until the stool is so weakened that the whole clump can be easily pulled up. On examining the roots they are found to be nearly all dead, those still living being dotted over with small, reddish, depressed, ulcerous-looking spots.

My attention was first called to the rind fungus in December 1891, by Mr. W. C. Hutson, Senr. who asked me to visit a field at Sunbury and tell him what was wrong with it: as he had observed certain clumps here and there in which some of the canes were dying. As I did not discover any shot borer on my first visit, and as microscopical examination disclosed the presence of hyphæ in the cells, I hazarded the opinion at the time, that the canes were suffering from some fungoid disease. The next estate on which I knew canes to be attacked, was Haynesfield, in St. John's parish, whence on the 14th January, 1892, the attorney, the late Mr. A. P. Murray, sent me some canes. These not only had the brown discolourations, now known to be so characteristic of the rind fungus disease, but had in addition the shot borer. Seeing these latter, I again examined the field at Sunbury, and there found that since my previous visit, some of the dying canes had been bored by the same insect.

At the time I first saw the canes at Sunbury, I was aware of the existence of a root fungus in St. John's parish, which was then doing considerable damage, as I had already shown Mr. Skeete, the attorney for Henley estate, a minute fungus on the roots of some canes obtained from that estate. I had even, with his permission, planted a few Caledonian Queen plants, on one of the most affected fields, so as to ascertain, whether like the hardier varieties of the wheat plant which are found to resist the "Rust," (*Puccinia graminis*), a fungoid disease, the hardy Caledonian Queen would not to some degree, resist the fungus attacking the roots of the Bourbon cane. So successful was the experiment, that the following year the attorney of a neighbouring estate, caused breadths of Caledonian Queens to be planted between breadths of the Bourbon. To such an extent did this cane resist the disease, that while in some fields the Bourbon canes were so badly attacked that they had to be destroyed, the Caledonian Queens were reported to have yielded two hogsheads of sugar to the acre.

For some time so great was the destruction wrought by these fungoid diseases, that legislative action was proposed, with the object of carrying out uniform and effectual remedial

measures; but this was ultimately dropped. In the meantime the diseases began to disappear on those estates on which the plan of planting hardy varieties had been adopted and in some instances the infected debris burnt as well.

On an estate adjoining Dodds where the whole of this treatment was carried out, I made, with the permission of the proprietor, certain experiments for the purpose of ascertaining how far this method for the extermination of the fungus had proved effectual: and as it may not be without interest, I here reproduce a copy of the report I made at the time:

"In continuation of my report of the 16th inst. on the "existing sugar cane fungus disease, and in confirmation of "what I then wrote with reference to those planters, who "have carried out, to some extent, the remedial measures "recommended by the authorities at Kew, such as burning the "diseased canes, and where the fields are badly affected the "debris therefrom, and have planted hardy varieties. I "now have the honour to forward herewith the results of "some experiments I have made with the assistance of Mr. "J. A. Gittens, of Oughterson plantation, an estate on "which the diseased canes and the debris therefrom have "been burnt for the past two years.

"A number of apparently representative holes of canes "were counted and the average number of individual "canes per hole ascertained: and a hole containing that "number of canes cut, weighed and tested. The results of "this experiment are given in the table attached. (*See* p. 40). "As will be seen on referring thereto, five of the hardy "varieties tested, were from fields on which no fallen leaves "were placed around the young canes last year, *i.e.*, 'trashed,' "as it is called locally.

"Mr. Gittens informs me that the manurial treatment "of all the fields from which the canes tested were "taken, was the same, with the exception of the one planted "with Red Ribbon, which only had chemical manure.

"The difference between the Bourbon and Caledonian "Queen is very marked, as they are quite close together, only "a small drain about two feet wide dividing the two fields. "In the one with the Caledonian Queen it is almost im-"possible to pass through on foot, while in the other with "the Bourbon, one can ride between the rows without the "horse injuring the canes."

As the following methods for the eradication of the fungus diseases, have apparently proved effectual in Barbados, they are suggested for adoption wherever the canes are found to be attacked.

(*a*) Only canes of a fungus-resisting variety should be planted.

(*b*) No plant should be taken from any stool having the appearance of being affected with disease.

(*c*) All plants should be soaked in water containing lime, carbolic acid, or Jeyes' fluid.

(*d*) Any plants that fail to germinate should be dug up and destroyed.

(*e*) Up to the time that it is possible for the labourers to pass between the rows, all canes having rind fungus should be cut out, and where they are affected with the root fungus, the stool should be dug out, and all infected matter burned.

(*f*) All spots of land affected with the root fungus, should be planted with some other crop for at least a year, and not merely planted with some other variety of the sugar cane, as is done now in some instances in Barbados.

(*g*) After all sound canes have been taken from a field, all rotten and diseased canes should be collected and burnt. When canes are too full of juice to burn readily, they should be crushed, the juice therefrom heated to boiling and the megass burned.

From past experience, I have every reason to believe, that if the above recommendations are carried out, in a few years there is every likelihood that the fungoid diseases now attacking the sugar canes in the West Indies, will be things of the past.

Among the hardy varieties which are fairly fungus-resisting, I may mention the Caledonian Queen, the Rappoe, the Queensland Creole, Naga B, the White Transparent and a seedling cane of great promise, viz: No. 147. So far as I know this seedling is free from the two fungoid diseases. That its yield is good, may be judged by comparing the results obtained with this cane and some of the other hardier varieties, given in the following statement:—

COMPARATIVE STATEMENT OF RESULTS obtained at Dodds with the Seedling Sugar Cane B. No. 147, and certain other canes usually cultivated in the Island.

Name of Cane	Sucrose per Imperial gallon Lbs	Glucose per Imperial gallon Lbs	Available Sugar per Acre Lbs
Seedling B. No. 147			
1894	1·941	·084	10,983
1895	1·790	·089	4,426
1896	1·820	·062	4,962
1897	1·580	·149	8,525
1898	1·842	·189	7,052
Average for 5 years	1·794	·114	7,190
Caledonian Queen			
1894	1·982	·052	8,330
1895	1·950	·052	5,209
1896	1·980	·032	4,098
1897	1·890	·045	8,219
1898	2·098	·026	4,830
Average for 5 years	1·980	·041	6,137

COMPARATIVE STATEMENT of RESULTS obtained at Dodds with th Seedling Sugar Cane B. No. 147 and certain other canes usually cultivated in the Island.—*Continued.*

Name of Cane.	Sucrose per Imperial gallon Lbs	Glucose per Imperial gallon, Lbs.	Available Sugar per acre Lbs.
Rappoe.			
1894	1·948	·050	9,416
1895	1·980	·031	3,073
1896	1·850	·045	3,562
1897	1·850	·012	7,633
1898	1·981	·038	5.962
Average for 5 years	1·922	·041	5,929
Naga B.			
1894	1·991	·056	7,527
1895	1·980	·051	4,605
1896	1 790	·058	2,655
1897	1·900	·053	7,930
1898	2 023	·037	6,754
Average for 5 years	1·937	·051	5,894
Bourbon			
1894	1·727	·118	7,064
1895	1·780	·090	3.480
1896	1·710	·071	3 672
1897	1·800	·083	6,934
1898	1·860	·068	4,899
Average for 5 years	1·775	·086	5,210
White Transparent.			
1896	1·840	·083	3,546
1897	1·570	·110	5,823
1898	2·001	·064	6,456
Average for 3 years	1·804	·086	5,275

I would also add that one gentleman who last year reaped fifty acres of these canes, on five different estates, of which he had the control, tells me that the fifty acres made 148 tons of sugar.

With regard to the shot borer, white blight, acarus and the large green fly, (Chrysopa), found on sugar canes, the evidence so far obtained points to the fact, that these with the exception of the black blight, do little or no damage, and for the most part, like the shot borer, are the followers of fungoid diseases.

RESULTS OF CERTAIN EXPERIMENTS MADE WITH CANES OBTAINED FROM "OUGHTERSON" PLANTATION ON 23RD AND 25TH FEBRUARY, 1895.

Name of Cane	Field Trashed or not	No. holes reckoned.	Average per hole of those reckoned.	No. of Canes in hole tested.	Manurial Treatment.	Imperial gallons of juice per acre.	Density Beaumé	Juice by Mill per cent.	Weight of Canes per acre. Tons	Weight of Canes per acre. Cwts.	Lbs. Sucrose per gallon of Juice	Lbs. Glucose per gallon of Juice.	Lbs of available Sugar per acre.
Rappoe ...	Not trashed	6	14.4	14	Farmyard & artificial manure ...	6521	10·75	70·0	46	13·21	1·891	·027	12,086
Caledonian Queen ...	Not trashed	12	14.1	14	Farmyard & artificial manure ...	5302	11·75	71·6	37	14·3	2·021	·026	10,508
Red Ribbon	Not trashed	12	13.1	13	Artificial manure only	6123	9·5	67·0	36	11·0	1·570	·065	9,019
White Transparent ...	Trashed	12	12.2	12	Farmyard & artificial manure ...	5017	10·5	71·1	36	4·3	1·716	·070	8,082
Burke	Not trashed	10	15.5	15	Farmyard & artificial manure ...	5852	10·0	70·6	39	13·23	1·483	·144	7,410
Naga B	Not trashed	10	14.3	14	Farmyard & artificial manure ...	5313	9·25	70·6	37	14·35	1·415	·102	6,705
Bourbon	Not trashed	58	9.1	9	Farmyard & artificial manure ...	1110	9·25	64·5	8	7·45	1·402	·070	1,439

DISCUSSION.

The PRESIDENT: We are extremely indebted to Mr. Bovell for his Paper, which is distinctly practical in its bearing on the cultivation of the sugar cane in this colony. I may mention that Mr. Bovell spent some time in the Jodrell Laboratory at Kew investigating the life history of *Trichosphæria*, and the thoroughness with which he then devoted himself to the subject has no doubt greatly assisted him in dealing with cane diseases in the West Indies. I would like to ask him to what he attributes the present partial disappearance of *Trichosphæria* and allied forms. Is it due to the superiority of the new canes as compared with the old: or is it due to the greater care now being taken in selecting healthy cane plants? I would also ask him if he has traced a direct relation existing between the attacks of the moth-borer and the occurrence of the fungus. It has been stated that the canes attacked by the moth-borer are almost invariably attacked afterwards by the fungus, which obtains access to the interior of the canes by means of the perforations made by the moth-borer. If this is established, it shows the necessity for the planter to keep the moth-borer in check. With regard to the recommendation to burn diseased canes in the field, is it really practicable to destroy diseased canes in this way? Is it not better to pass them through the mill and then burn them in the boilers?

Mr. BOVELL: I believe that fully 90 per cent. of the canes attacked by rind fungus had already been attacked by the moth-borer: but I may add that I have seen the rind fungus on some canes that had not been attacked by the borer. I attribute the partial disappearance, at present, of the fungus in this island to the substitution of selected seedling canes in the place of the Bourbon cane: and to the greater care taken in selecting healthy tops for planting. Also to the more general practice of cutting out and burning diseased canes as suggested by the President.

Professor HARRISON: It may be of some interest to know that some time ago there was a good deal of rind fungus present in the cane fields in Demerara, but quite recently it disappeared. In our case, its disappearance was probably due to the heavy rainfall during the month of December.

Mr. J. H. HART (Trinidad): During a visit to Barbados in 1892, I came to the conclusion that the primary cause of the disease then affecting the sugar cane was the fungus and not as we believed in Trinidad, the shot-borer (*Xyleborus perforans*). The latter probably fed on the fruit of the fungus. The fungus now known as *Trichosphæria sacchari* exists in two forms, one affecting the cane itself, the other its root. The latter has received the name of *Colletotrichum falcatum*. Recently typical *Trichosphæria sacchari* was observed on an estate in Trinidad. The disease is still prevalent in some localities in that Colony. I have attributed the attack of the fungus to "constitutional weakness" in the sugar cane, due to continued

treatment and cultivation on the same land. I noticed a similar "want of vitality" in cacao trees in Nicaragua in 1893, but some plants raised from Nicaragua seed in Trinidad are now most vigorous trees and less susceptible to disease than any known sorts. It would be distinctly advantageous in the case of sugar canes to raise other crops or let the land lie fallow. Possibly the fungus will never become a thing of the past; we shall always have to fight it. We should also cultivate canes that show greater immunity to disease.

The PRESIDENT: What cane is now chiefly cultivated in Trinidad?

Mr. HART: The Bourbon or Otaheite Cane.

The PRESIDENT: A remark dropped by Mr. Hart in regard to "constitutional weakness" existing in plants may be misunderstood. There is, I believe, no such thing as "constitutional weakness" existing as a general condition of plant life. If we cultivate our plants carefully and suitably, they will not suffer; and, strangely enough, Mr. Hart himself disposes of the theory by the account he gives of the result of introducing Nicaragua cacao to Trinidad. Careful treatment and giving the plants under our care exactly the conditions required by them, would entirely prevent deterioration, but not necessarily, of course, disease.

Mr. FRANCIS WATTS (Jamaica): Disease in sugar cane is a subject of vital importance in the Leeward Islands. In one year I estimated that the planters lost 40 per cent. of the value of their produce from diseases, probably *Trichosphæria*. This is a very difficult subject to deal with as it merges itself into a series of diseases. It begins with the moth-borer, it merges into the shot-borer, it becomes a stem disease and then a root disease. The first experience of it in Antigua was during a period of profound drought: the canes were drying up and the planters were in despair. Mr. Barber, the Superintendent of Agriculture, drew attention to the shot-borer, and efforts were made to eradicate this. The planters took the view, which Professor Harrison took just now, and thought that three inches of rain would do all that was required. The next year was one of the most favourable from a planter's point that we ever had, but cane disease was more rampant than ever. This entirely disproved the idea that a favourable season would rid us of the pest. We then began to attach great importance to the use of seedling and other varieties. These were by no means immune; but there was one striking instance that came under my notice, where a Barbados seedling remained healthy and grew most vigorously, when almost interlaced with the White Transparent having hardly a sound cane in the whole lot. That appealed to the practical man, and advantage was taken of the new canes supplied from the Botanical Station. In St. Kitts, the Transparent cane suffered from disease quite as much, if not more than, the Bourbon. It is possible that a cane which is immune in one locality may entirely break down

in another. We must use seedling varieties so long as they serve our purpose, but discard them immediately if liable to disease. A good many theories are put forth as to the cause of disease. One is, that it is due to the action of fertilizers and artificial manures. There happens to be a striking refutation of this in the case of Montserrat where the cane fields are in a frightful condition of disease and yet no artificial manure has been used. I believe that if all the facts connected with the outbreak of cane disease in Montserrat, St. Kitts, Nevis and Antigua, were collated, they would contain valuable information as to the underlying and fundamental cause of these diseases.

The Conference then adjourned (at 1 o'clock) for luncheon. After luncheon the Conference resumed at 2 o'clock.

The PRESIDENT: The subject that will occupy our attention this afternoon is one not only of great importance but of immediate interest. In my opening address I referred to the urgent necessity that existed in the smaller Colonies for preventing the loss incurred by imperfect means for crushing the canes and in manufacturing the sugar. I placed this loss, after citing reliable authorities, at about 35 to 45 per cent. of the total sugar found in the canes. No industry where such loss is incurred can hope to survive. The papers to be placed before you this afternoon will endeavour to grapple with this difficult question and will, I hope, clearly point out how the serious loss I have indicated may be prevented by practical and effective means.

CENTRAL FACTORIES FOR THE WEST INDIES.*

By WILLIAM DOUGLAS, F.I.C., F.C.S.

With low prices for sugar at present, and not unlikely still lower values in the near future, it has become imperative, if the industry is to be carried on, that the cost of production should be reduced.

In progressive sugar countries many improvements in agricultural methods and in manufacture, resulting in greater economy, have been effected during recent years: the most striking, and, perhaps, the most important, being the reformation which has taken place in manufacture.

Plantations depending on the primitive and wasteful processes which have served in the past, can no longer, in average

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seasons, place sugar in the market at a profit. Many are kept in operation at a loss in the hope of better times to come, others unable to maintain the struggle with better armed competitors, have been abandoned altogether. Those still carried on occupy a nearly hopeless position. There is no surplus revenue available to effect the necessary improvements, or even to provide adequate maintenance; and it is a mere matter of time till they disappear also, unless a radical change for the better is soon made.

Much discussion has taken place, on the most effective manner of applying improvements in manufacture in backward sugar countries, and to-day it may be taken as practically settled, that where plantations are individually small, central factories—preferably on a co-operative system, as between planter and manufacturer, equipped with the most approved appliances, and the manufacturing processes directed by competent specialists—constitute the most satisfactory means. Such factories, well designed, and of suitable capacity, can, at moderate outlay per ton of output, be provided with machinery capable of yielding the highest extraction of sugar from the cane known to be attainable at present; while labour-saving devices can be profitably introduced which are quite beyond the reach of small establishments, if their capital is to be kept within reasonable and necessary limits.

Wherever a sufficient cane supply is within easy reach, large factories of a capacity of 18,000 to 20,000 tons of sugar over a crop season of the usual duration, should be erected, rather than two or three smaller ones. The cost of machinery in proportion to work done, is much reduced in factories of large capacity, and it becomes possible to profitably install appliances to insure the highest extraction, the annual charges on which would swamp a small undertaking. The most highly skilled direction can be retained, and increase of skill carries with it increase of output from machinery and the best industrial results in its operation. With increase of volume of manufacture, expenses for management, labour, fuel, and other supplies are proportionately reduced.

The cost of new plant to replace worn-out apparatus, or necessary to maintain the continuous advance in efficiency of manufacture, involves a smaller charge per ton of output. Depreciation is favourably affected, large houses being provided with complete repairing shop and staff of skilled mechanics, keeping up a thorough maintenance. Indeed, with large output, the inducement to improve the smallest working details, is so great, that each new season generally finds the plant in as good or even better condition than before. Old parts being renewed, before they begin to interfere with efficiency of working, and improvements adopted on a scale quite impossible in small factories.

The difference in yield and value of products from raw material, between the old sugar works (single crushing and muscovado type) and the results obtained in well-equipped

factories is enormous. Many comparisons are available, and may be found in technical journals, public reports and elsewhere.

The following, Table I, gives an approximate estimate of the average results obtained, by the treatment of canes containing 13·5 % of sugar by single crushing with inferior mills and muscovado process, in the island of Barbados. The data are derived from experimental work carried out by Professor Harrison and others, and from personal enquiry in the island last year. The results are drawn up in a form suitable for easy comparison with those obtained in sugar manufacture, as carried on under more modern conditions in other countries.

TABLE I.

Barbados, average single crushing and Muscovado process.

	CANE.		JUICE.
† Saccharose in Canes	13·50	100·00	
Saccharose in Megass	4·00	29·60	
Saccharose in Juice Extracted	9·50	70·40	100·00
Saccharose in 1st Sugar	6·44	47·70	67·75
Saccharose in Molasses	1·68	12·50	17·75
Saccharose in Scum Cakes Saccharose in Washings Saccharose Inverted Indefinable Loss of Saccharose	1·38	10·20	14·50
	9·50	70·40	100·00
* 1st Sugar (Pol. 90·0)	7·15	53·00	75·28

Experience in economical production has, under the pressure of adverse prices, been rapidly accumulating in progressive sugar countries, and many factories with improved machinery which a few years ago were looked upon as well-equipped, can no longer be rightly classed as of that description.

The following tables shew the results obtainable, by the improved machinery and processes which have been introduced

† Saccharose and Sucrose are interchangeable terms: both signifying Cane-sugar.

during recent years in the West Indies and other cane-producing countries.

TABLE II.

Dry double crushing with the best mills, steam clarification, filterpresses, multiple effect evaporation, boiling in vacuo, 1st and 2nd refining sugars made.

	CANE.		JUICE.
Saccharose in Canes	13·50	100·00	
Saccharose in Megass	2·03	15·00	
Saccharose in Juice Extracted	11·47	85·00	100·0
* Saccharose in 1st Sugar	9·44	69·96	82·3 { 72·4
Saccharose in 2nd ,, ...			9·9
Saccharose in Molasses	1·36	10·11	11·9
Saccharose in Scum Cakes	0·14	1·02	1·2
Saccharose in Washings			
Saccharose Inverted	0·53	3·91	4·6
Indefinable Loss of Saccharose			
	11·47	85·00	100·0
* 1st Sugar (Pol. 96·5)	8·60	63·75	75·0
2nd Sugar (Pol. 90·0)	1·26	9·35	11·0

TABLE III.

Double crushing with maceration, same manufacture as II, but low sugars' returned into process. Total output being 96° Crystals.

	CANE.		JUICE.
Saccharose in Canes	13·50	100·00	
Saccharose in Megass	1·62	12·00	
Saccharose in Juice Extracted	11·88	88·00	100·0
* Saccharose in 1st Sugar	9·74	72·16	82·0
Saccharose in Molasses	1·38	10·21	11·6
Saccharose in Scum Cakes	0·14	1·05	1·2
Saccharose in Washings			
Saccharose Inverted	0·62	4·58	5·2
Indefinable Loss of Saccharose			
	11·88	88·00	100·0
* 1st Sugar (Pol. 96·5)	10·10	74·8	85·0

TABLE IV.

Triple crushing with maceration, manufacture as in II and III, with selected low products returned into process. Methodical boiling and improved treatment of the *masse cuite.* Total output being 96° Crystals.

	CANE.		JUICE.
Saccharose in Canes	13·50	100·00	
Saccharose in Megass	1·35	10·00	
Saccharose in Juice Extracted	12·15	90·00	100·0
* Saccharose in 1st Sugar	10·32	76·41	84·9
Saccharose in Molasses	1·26	9·36	10·4
Saccharose in Scum Cakes	0·14	1·08	1·2
Saccharose in Washings ... . .. / Saccharose Inverted ... . / Indefinable Loss of Saccharose	0·43	3·15	3·5
	12·15	90·00	100·0
* 1st Sugar (Pol. 96·5) recovered	10·69	79·2	88 0

TABLE V.

Same process as IV, but with best triple mills. Data from a well-known Hawaiian Factory, crop 1895. Three sugars (refining) made.

	CANE.		JUICE.
Saccharose in Canes	15·52	100·00	
Saccharose in Megass	1·17	7·54	
Saccharose in Juice Extracted (Quot. Purity 86°)	14·35	92·46	100·00
* Saccharose in Sugars I, II, and III	12·90	83·13	89·91
Saccharose in Molasses	0·77	4·96	5·36
Saccharose in Scum Cakes	0·17	1·09	1·18
Saccharose in Washings ... ... / Saccharose Inverted ... ... / Indefinable Loss of Saccharose	0·51	3·28	3·55
3rd Sugar (Pol. 85) Recovered 0.67 ... ... / 2nd ,, (,, 91.1) ,, 2.52 %	14·35	92·46	100·00
* 1st Sugar (Pol. 96.5) ,, 10.40 ,, ...	13·59	87·57	94·71

In Table V., the yield of three sugars from the saccharose in the juice is very high, but from that point of view even better results have been obtained by C. Saillard at the Mercedita factory, Cuba, crop 1894, and by Manoury at the San Isidro factory, Argentine Republic, last year. In the latter case carbonatation was employed and "malaxage" of the *masse cuite*. In both cases selected low products were returned into the process. For comparison with the above data, the results obtained in a good German beet sugar factory are given in the following table.

TABLE VI.

Beet sugar factory—Diffusion, Carbonatation, etc.

	BEETROOT.		JUICE.
Saccharose in Beetroot	13·50	100·00	
Saccharose in Pul . etc.	·45	3·33	
Saccharose in Juice Extracted	13 05	96·67	100·00
Saccharose in all Sugars	11·21	83·05	85·91
Saccharose in Molasses	1·19	8·81	9·12
Saccharose in Scum Cakes			—
Saccharose in Washings	0 65	4·81	
Saccharose Inverted			ut
Indefinable Loss of Saccharose			
	13·05	96·67	100·00

In recent beet sugar manufacture, practically as high a recovery of Saccharose from the beet as that shewn in Table VI. is obtained in one sugar, by returning selected low products into the process with improved treatment of the *masse cuite*.

A general idea of the quality of the work done in Beet sugar houses, may be gathered from the following table which contains the results obtained in nine factories within recent years.

TABLE VII.

GERMAN SUGAR FACTORIES.

	Sucrose in the Beet.	Sucrose in the Sugars produced.	% Sucrose recovered.	Sucrose in the Molasses.	Losses in Manufacture.	
1	14·90	11·88	79·73	1·57	1·45	% of Beet.
2	14·07	11·14	79·18	1·58	1·35	—
3	13·21	10·25	77·59	1·62	1·34	—
4	13·49	11·21	83·10	1·28	1·00	—
5	13·44	10·55	78·50	1·57	1·32	—
6	15·97	13·23	82·84	1·53	1·21	—
7	12·73	10·63	83·50	1·02	1·08	—

FRENCH SUGAR FACTORIES.

A	12·50	10·31	82·48	1·25	0·94	—
B	12·27	9·37	76·37	2·10	0·80	—

When contemplating the establishment of new factories, the progress made by sugar makers in other cane countries and in the beet industry, must ever be kept in view, and arrangements which are not capable of giving economical extraction, approximating to that obtained by our competitors, should be avoided.

Large cane sugar factories can at present be constructed, capable of extracting not less than 80% of the sugar in the cane as 96 crystals (commercial yield), in a profitable manner. I am not aware that this extraction is quite obtained, continuously, anywhere in the West Indies; the means of effecting it are, however, known, and well within reach. When it is remembered that the largest item in the cost of producing sugar is the charge for cane, the importance of reducing this expense per ton of sugar to the greatest extent possible, by means of high extraction, cannot be over estimated.

It has been shown that only large factories are in a position to install at moderate cost per ton of output, the numerous expensive appliances necessary for the attainment of the highest industrial results, and that apart from increased yield, they are economical from the concentration of processes by powerful apparatus under skilled direction. Such conditions render possible a reduction of general expenses, which cannot be approached by small factories, however well equipped.

The separation of agriculture and manufacture in the cane sugar industry involves some disadvantages; the benefits to be obtained, however, outweigh these. As many sources of per-

manent expense will be removed, field problems will be likely to receive better attention. The qualities required by the modern sugar maker and those requisite for the agriculturist, are seldom or never found in the most highly developed form in the same person. The great improvements in manufacture are chiefly results of the application of specialists; similar results are likely to follow under the new conditions, in the other branch of the sugar industry. When planters are paid per ton of canes delivered, the reduction of cost of growing will receive even closer attention than has hitherto been the case, and economies, the possibility of which is at present only dimly seen or entirely unperceived, will without doubt be realised.

For the successful establishment of Central Factories, the following amongst other considerations are essential:—

1. The cane-growing district to be served should be fairly compact and easily reached by the factory transport system, without undue cost in initial outlay: and it is important, *other conditions being fulfilled*, that the site of the factory should be as nearly as possible in the centre of the district, so that the cost for transport of canes may be kept at a low figure.

2. A *clientèle* of cane growers, closely attached to the factory by having a pecuniary interest in its success, and under such administrative control by the factory authority, during the crop season, as to insure a regular supply of freshly cut canes. The canes should be bought by the ton, delivered on the factory rolling stock, old, immature, or badly cleaned canes being subject to rejection. The varieties of canes to be accepted as of average quality, must be decided by the factory authority in consultation with representatives of the planters interested in the undertaking. Payment for other varieties must be subject to special regulations.

At present in colonies where canes contain an average of 13½% of sugar, 10/6 per ton might be paid on delivery, the factory bearing the cost of transport. Subsequently, a further payment should be made, when the factory accounts are closed at the end of the season, from the profits of the year's operations, after provision has been made for interest on capital, sinking fund and maintenance.

In co-operation between planter and factory, lies the solution of the difficulty as to price to be paid for canes. The dangerous and ever-present difference of opinion as to value, can be most easily surmounted by giving the planter a direct pecuniary interest in the operations of the factory, in proportion to the quantity of canes supplied. The adjustment of the areas to be reaped on individual plantations throughout the crop season can be easily arranged.

3. The laying down of an efficient system for the transport of canes from plantations to factory—generally railways. These should be of light construction to minimise first cost, but of good material well laid down, so that running expenses and charges for maintenance may be kept low. It is import-

ant with regard to first cost of transport system, that the cane-growing district should be fairly level, so that easy gradients may be obtained without much earthwork.

For factories of moderate size, 8000 to 9000 tons sugar output per crop, lines similar to those used by the Colonial Sugar Refining Co. of Australia might be employed—the main line being laid with flat-footed rails, 24 lbs. per yard, hardwood or steel sleepers, lightly ballasted, gauge 2 feet, with steam traction. Such lines cost about £800 per mile, laid down complete, exclusive of rolling stock and cost of land. Light feeding lines from fields to permanent way, in portable sections, should also be provided, animals being used on them for motive power.

For large factories, 17,000 to 20,000 tons sugar output per crop, a more substantial system of permanent way should be adopted—gauge 3 feet or metre, with 40 lb rails steel or hardwood sleepers, and the line well ballasted, to prevent undue deterioration by heavy rainfall. The main lines should be provided with economical mechanical loading stations. The cost for such lines complete, including land, should not exceed £1800 per mile exclusive of rolling stock. If a suitable railway already exists in the district, the gauge of the factory lines should be made the same if possible, so that factory rolling stock may be available over it if running powers are procurable. With an average lead for canes, of 5 to 6 miles, the cost of transport should not exceed 1/6 per ton, and it could probably be done for less, with factory in a favourable situation.

4. A suitable location for the factory should be of easy access by lines from the plantations, these having, if possible, a ruling gradient in favour of the load. It should have facilities for the economical shipment of produce, and be within easy reach of an abundant supply of cheaply obtainable water. The latter point is most important, as in modern sugar manufacture enormous quantities of water are required for condensing and other purposes. The factory should preferably be situated in a populous neighbourhood, near a town or large village, in order that the supply of labour necessary during the manufacturing season, may be obtained with little difficulty and expense.

5. The factory must be of capacity suited to the probable cane supply. Indeed, undertakings from cane growers are necessary before erection should be proceeded with at all. The plant should be of modern design, embodying the improvements suggested by the most recent experience. The apparatus employed should be of well approved type, the arrangement of the machinery simple, and the design should be elaborated under the guidance of competent expert advice, in order to insure due accord between the processes with unity of idea throughout, high extraction with economical production being kept always clearly in view.

6. In the establishment of co-operative factories, the capital required should be raised (under guarantee or otherwise) as cheaply and directly as possible. The margin of profit in sugar production, in British colonies at present, is not sufficiently

large to bear the burden of over capitalization, which can be so readily imposed by our present-day system of company flotation. The installation of central factories has, of course, difficulties peculiarly its own. The raw material is bulky, extensive and costly permanent transport arrangements require to be laid down and maintained, and the supply of canes from various points must be accurately adjusted from day to day. With large output, the products must be of a nature and quality to command prompt and ready sale at current prices, without disturbance of markets. The requirements are, however, well understood, and, given a well-designed modern installation and a plentiful supply of cheaply-grown canes, good management remains the final important factor necessary to insure success.

CENTRAL FACTORIES:

Their advantages and the conditions necessary for their successful establishment in the smaller West Indian Islands.

BY FRANCIS WATTS, F.I.C., F.C.S.

The changed conditions confronting the sugar industry of the West Indies have attracted almost universal attention during the last two years. The situation has been so grave as to call for Imperial investigation, and it is a direct consequence of that investigation that we are met together in conference at the invitation of Dr. Morris, the Imperial Commissioner of Agriculture for the West Indies.

It is impossible to arrive at a clear understanding of the position of the sugar industry, unless we separate that industry into its two natural divisions: (1) the growing of the sugar cane, and (2) the manufacture of that cane into sugar and other products. In all discussions it is of the first importance to keep these two parts quite distinct. Much of the confusion which has arisen, and many of the contradictory statements which have been made, may be traced to a large extent to a neglect of this precaution.

Roughly the West Indian colonies may be divided into two groups:—

(1) Those in which the conditions are eminently favourable to the production of canes rich in sugar.

(2) Those in which there are certain disadvantages either in the way of insufficiency of labour, difficulties inherent in the agricultural conditions of the colony, or a soil and climate resulting in the production of canes of somewhat low saccharine richness and of low purity.

In the first group we may include Barbados, the Leeward and the Windward Islands. In the second, British Guiana and Trinidad. Jamaica perhaps falls between the two, but inclining more to the first group.

Now in the colonies of the second group, we find that the

agricultural disabilities have been combated by the introduction of machinery of an improved type, and by the application of the best methods which engineering and scientific skill can suggest. This development has taken place along natural lines: the lower saccharine strength and purity of the juice rendered the manufacture of sugar, with simple and crude appliances, a difficult matter, so that the need for improvements in manufacturing methods was forced upon those engaged in the industry. These improvements were adopted as more pressing and more easily secured than alterations in the agricultural conditions. At the same time improvements have been effected on the agricultural side.

In the colonies of the first group canes were grown easily, labour was plentiful, land productive and, what is of the greatest importance, the juice obtained from the canes was of great saccharine richness and purity. Under these conditions planters were able to make sugar easily with simple appliances, the muscovado system with all its defects and losses suited the conditions then obtaining in these colonies: vacuum pans for the manufacture of crystal sugars were introduced only in a tentative manner, and there the industry remains until to-day. Improvements in agriculture were more easily obtained in these colonies, less expenditure of capital was needed, and the results were speedily manifest and appreciable. Thus we have in Barbados, as the typical example, and to an almost similar extent in some of the Leeward Islands, a highly developed agriculture, with cane fields well tilled and as free from weeds as if they were gardens, while the manufacture of sugar remains imperfect, wasteful, and the surprise and wonder of those who are familiar with the methods followed in most other countries.

The quality of the juice dealt with in these muscovado-making colonies may be gathered from the analyses which I had an opportunity of making in Antigua.

In 1893 ten estates producing 3,431,570 Imperial gallons of juice afforded me the following figures as averages of the season's work:—

ESTATE.	I.	II.	III.	IV.	V.	VI.	VII.	VIII	IX.	X.	True Average, I to X.
Sucrose pounds per gallon of Juice ...	1·837	1·963	1·992	1·841	1·866	1·962	1·872	1·894	1·945	1·936	1·91
Glucose	·073	·056	·062	·089	·077	·068	·082	·072	·079	·092	·0744
Glucose Ratio ..	3·99	2·85	3·21	4·83	4·16	3·49	4·40	3·79	4·07	4·75	3·888

In 1894 ten estates producing 4,628,640 gallons of juice had the following composition:—

COMPOSITION OF THE JUICE OF CROP 1894.

ESTATE.		II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	True Average I to X.
Total Solids lbs. per gallon	2·0023	2·171	2·239	2·128	2·020	2·129	2·048	2·253	2·109	2·202	2·085
Sucrose	1·7203	1·927	1·932	1·825	1·730	1·885	1·742	2·009	1·798	1·914	1·806
Glucose	·1037	·064	·080	·078	·094	·083	·093	·069	·093	·086	·090
Non Sugar	·1386	·179	·226	·225	·196	·161	·213	·175	·218	·202	·189
Glucose Ratio	6·02	3·36	4·17	4·28	5·45	4·43	5·35	3·43	5·15	·450	4·973
Purity	85·918	88·77	86·31	85·77	85·63	88·54	87·04	89·17	85·26	86·90	86·62
Sp. Gr. at 84° Fh.	1·0744	1·0800	1·0825	1·0787	1·0744	1·0787	1·0755	1·0830	1·0779	1·0812	1·0790
Total Solids % by weight ...	18·636	20·100	20·680	19·73	18·80	19·74	19·04	20·80	19·57	20·37	19·330
Sucrose	16·012	17·840	17·850	16·920	16·100	17·47	16·200	18·550	16·860	17·700	16·859
Glucose	1·335	·600	·745	·724	·877	·774	·866	·637	·860	·797	·832
Non Sugar	1·289	1·657	2·088	2·086	1·824	1·493	1·980	1·616	2·022	1·868	1·639

It will be observed that there is some falling off in the richness of the juice in the second year; this I now attribute to the early stages of the attack of rind fungus, (*Trichosphæria*), for a continuation (in part) of the analysis in subsequent years showed a steady decline in the saccharine richness of the juice concurrent with the attack of rind fungus. Indeed, I believe that in any district where an outbreak of a fungoid disease of this kind is about to become a serious trouble, the planters will find this falling off in the saccharine richness of the juice affords them the first indication of the approaching trouble.

In accounting for the retention of the muscovado industry, it must be remembered that the system possesses some advantages, and under conditions which prevailed, until a few years ago, it was remunerative. Estates in the colonies in question being mostly small and owned by different proprietors, it was natural that each should endeavour, as far as possible, to preserve its own identity. This was easily possible under the muscovado system, where a wind mill or a small steam engine, with buildings and machinery of the simplest type, served for the production of muscovado sugar almost equally well on a small scale as on a large one. Then again, the muscovado system results in the production of molasses of good quality, which, when sugar was costly, was largely used as an article of food, and thus commanded a ready sale at remunerative prices.

The altered conditions of the past few years have pressed heavily upon the sugar industry. The great fall in prices has pressed equally upon both groups of colonies, those having machinery for the manufacture of crystal sugars, and those adhering to the muscovado system. But the latter have to bear an additional burden; molasses has fallen in price, so that a short while ago it was almost unsaleable. Several causes combined to produce this depreciation in value. Tariffs, competition of other countries, diminished demand for molasses as a cheap human food, substitution of refiners syrups and glucose syrup for the higher grades of molasses, and others, led to a serious fall in values.

Whatever may have been the cause, the fact remains that by a depreciation in the value of molasses the muscovado industry lost one of its greatest supports. The industry, in fact, is largely dependent upon a ready sale for molasses. With a low price for this commodity, coupled with a low price for sugar, the industry has been carried on at a loss. This state of things cannot continue; improvements must be made or the industry must be abandoned.

In order to ascertain in what direction improvements should be made, I spent some time in investigating the conditions under which muscovado sugar is produced in Antigua, and endeavoured to ascertain what were the defects and losses of the system. The conclusions at which I arrived were briefly as follows:—

First: that the destruction of sugar by inversion during the process of manufacture is not so great as was imagined. Where juice of good quality is manipulated, it may be about 3

per cent. of the sugar dealt with, and in a well managed boiling house it should not be much more than 4 per cent., while it may be considerably lower when very rich juice is manipulated. Instances have come under my notice where, from careless working and the use of imperfect appliances, the loss from inversion has greatly exceeded these figures, and has been as high as 10 per cent. From this it follows that there will be no great gain in the manufacture of muscovado sugar by the introduction of appliances having merely for their object the reduction of the loss by inversion.

It then appeared that the chief defect of the system was the form in which the sugar was produced. This consists of a mass of small crystals which are difficult to manipulate. The molasses is separated with difficulty, and the resulting sugar must be re-dissolved and re-crystallised in order to meet the requirements of the consumer of to-day. Any process which leads to an improvement in the grain or crystal is a distinct advance, provided that the improvement can be secured at a commensurate cost. Now in Barbados, for many years past, efforts have been made to secure improvements of this nature by means of oscillators, as by constantly stirring the sugar during the process of crystallisation a larger crystal results. We have in this an early instance of a system which is being introduced into modern factories, both beet and cane, the method of crystallisation in movement. I do not know if the Barbados planter can claim to have originated this improvement, but it seems probable that he can. Improvements of this kind, however, are quite overshadowed by an improvement which affords all the advantages of crystallisation in movement, with many others. I refer to the production of sugar in the vacuum pan. We may at once contrast the difference between the muscovado and vacuum pan systems. In the first the sugar crystallises only after the boiling is finished, the high temperature of the boiling syrup preventing the formation of grain, at the same time a high temperature leads to inversion of the sugar so that the boiling must be stopped when the syrup still contains about 12 to 13 per cent. of water. Now in the vacuum pan boiling is carried on until the proportion of water is reduced to about 5 per cent. But while the concentration is being carried to this high pitch, the sugar is already crystallising in the rapidly moving and boiling mass, the small grains, first appearing as fine points, gradually grow in size, and finally appear as large crystals of remarkable purity easily manipulated and from which the molasses is separated with the greatest ease. Here then the two systems stand in the strongest contrast, and it seems to me to be futile to look for safety in improvements in muscovado methods, though minor improvements may be made; there must be a complete abandonment of the method for that of the vacuum pan.

A third point which came prominently under my notice was the very great loss sustained in the muscovado industry by the imperfect crushing which the small mills afforded. Where the estates are small, as they usually are where muscovado sugar is produced, the mills employed must be small also; at most three-roller mills are employed. Now it is admitted

that thorough extraction of the juice from the cane can only be secured by repeated crushings. One crushing, however powerful, will still leave a large amount in the megass. Hence mills with four, five, seven, eight, and up to nine rollers are now in use in large factories. Small muscovado estates cannot afford these appliances. Imperfect expression of the juice is, therefore, a defect which usually accompanies the muscovado system, though not necessarily an intregal defect of that system. This defect, from a monetary point of view, is probably the greatest of all. My own observations lead me to conclude that there are few three-roller mills in the muscovado colonies which express 60 per cent. of the weight of the cane, as juice, when the results are reckoned over the whole of the crop. This is the only correct way of stating a mill's efficiency. I felt that I was not placing the figure too low when I stated my belief that the average percentage of juice expressed by the mills of Antigua did not exceed 55 per cent., taking all the work done in the island into consideration. Herein lies the greatest loss sustained by the industry in muscovado colonies. Good mills are capable of expressing from 70 to 75 per cent. of juice, from cane of the character of that to be dealt with in these colonies: so that for every 55 pounds of juice now obtained, from 15 to 20 pounds are lost: the loss is, therefore, from 27 to 36 per cent.

Amongst the experiments made at Skerretts in Antigua, by Mr. F. R. Shepherd and myself were some which were of interest in this connection. The canes grown for the purposes of experiment were crushed by a small Chatanooga mill, which expressed about 66 to 69 per cent. by weight of juice. This high crushing being due, no doubt, to the fact that the canes were fed to the mill singly and slowly: the resulting megass was submitted to pressure in a small hydraulic press, when we usually obtained an additional quantity of juice equal to about 6 per cent. on the weight of the canes, thus bringing up the total crushing to 72 to 75 per cent. in the case of Bourbon canes. In bringing these facts to the notice of planters, a good deal was said about the inferior quality of juice obtained by this final and high crushing. To answer these objections a number of samples of juice thus obtained by the hydraulic press have been analysed and the results embodied in the reports of the Antigua Experiment Station. From these it appears that this juice contains about $\frac{4}{5}$ths of the quantity of sugar contained in the mill juice, and that, while of somewhat lower purity than the mill juice, the co-efficient of purity was rarely more than 6 or 7 points below that of the mill juice: for instance, when the co-efficient of purity of the mill juice was about 86, that of the juice from the press was about 80 to 82. So that the juice which we obtained by means of high crushing was relatively rich in sugar and of very fair purity. In most instances, however, the juice was dark in colour and would necessitate special treatment in the factory for the production of high grade sugars. I have alluded to these results because I have been told so often by planters that they fear the juice to be obtained by high crushing will be of such poor quality as not to be worth the trouble and expense of obtaining it.

The time has arrived when the muscovado industry is carried on either at a loss or at so small a profit as to give but a poor return to those engaged in it. Now the brief statement which I have made of some of the chief defects and losses of the system will show that there is yet an opportunity for the establishment of a sound and remunerative sugar industry even at present prices. If the sugar growers in muscovado districts have been able to produce sugar in the field so cheaply that the muscovado system, with its enormous loss of material and its low quality of produce, can hold its own, or nearly hold its own, it follows that the prevention of these losses will convert the sugar industry in these places into a safe and remunerative one. I am convinced that the muscovado system of manufacture involves losses which amount to from 35 to 45 per cent. of the value of the produce now obtained.

In the main I believe these facts are fully admitted so I have only briefly touched upon them without now endeavouring to prove them: and, being admitted, there is a wish to adopt methods which will prevent those losses and place the sugar industry of Barbados, the Leeward and Windward Islands upon a sure footing.

It follows that the sugar planters of those colonies where the muscovado industry has survived as a staple industry up to the present time, have much to gain. They have such unutilized advantages as will enable them to increase the quantity and value of the sugar products while decreasing the cost of manufacture. Other colonies with agricultural and other disabilities have been compelled to utilize these advantages long ago. The planters of Barbados, the Leeward and Windward Islands have yet these advantages to reap. If up to the present time they have been able to hold their own, or even approximately hold their own, it is not too much to expect that the adoption of improved methods will result in returning prosperity to the sugar industry a prosperity which will not be shaken even by prices lower than those already experienced.

To gain these advantages must mean the abandonment of the muscovado industry and the adoption of modern methods including high crushing, multiple-effect evaporation, crystallization in vacuum pans.

Now the question arises: How are the colonies to make the change, which will be a radical and important one, touching the interests of almost every resident, and changing the basis of trade within these colonies?

I am familiar with the conditions prevailing in one island of the Leeward groups,—Antigua—and I will consider how the desired change may, in my opinion, be best brought about in that colony.

In order to secure the advantages of modern machinery, I believe it is necessary to have factories capable of manufacturing from 2,000 or 3,000 tons up to 10,000 tons of sugar in 100 days. Most, if not all the advantages, can be secured in fac-

tories of 3,000 tons; such a factory may possess at least a 5-roller mill with a cane crusher or shredder, it can have a triple effect and two or three vacuum pans, with the necessary clarifiers, centrifugals and other appliances required for the manufacture of refiners' crystals and granulated grocery sugars, both white and yellow. Comparatively small factories of this class are easily and cheaply worked, they are large enough to be able to afford to pay adequate salaries for the class of men required to work them, large enough to have good machinery, and large enough to absorb the canes of a given area without the necessity for long and expensive transport.

As to cost, I believe engineers will endorse my statements when I say that I believe a factory of this capacity could be erected for a sum of £30,000 exclusive of tramways in such places as Barbados or Antigua where transport is easy. Iron buildings would be employed for the most part, and these are light, easily shipped, cheap and durable. This question of cost is most easily settled, for, once the nature, capacity and site of the factory have been determined, estimates or tenders may be called for. In the mean time the cost of existing factories can be ascertained.

The question of site is an important one, and it seems to me it must be determined largely by the facility with which canes can be delivered to a given spot: for we must not lose sight of the fact that about ten tons of canes are required for the production of one ton of sugar, and further that canes are less easily carried than sugar. The site must, therefore, be selected with a view to the easy delivery of canes.

A second factor in determining the site is an adequate water supply: an ideal site is on the bank of a stream whence large volumes of cold water may be withdrawn, and into which the warm waste water can be discharged. Next to this comes a position on the sea, for sea-water may be employed for condensing purposes quite as readily as fresh water, the water being required for a purpose similar to that for which it is used in every sea-going steamship. But sites well suited for the delivery of canes need not be neglected because they are neither upon a river nor near the sea, provided that water can be conserved in ponds or reservoirs. If enough is stored, the same water may be used over and over again if means are taken to cool it on its exit from the factory. As for the actual supply of water, this is not such a serious question, as practically all the juice is condensed into water and so rendered available for future condensing work. We may expect to recover over 1,000 gallons of water for every ton of sugar made, so that our factory alone affords a water supply of 30,000 gallons every 24 hours.

Now in Antigua there are many sites well suited for sugar factories, and, what is perhaps of equal importance, I believe that the owners of sugar estates around these sites are to a large extent prepared to combine their interests for the erection and working of factories for their mutual benefit. In

most instances strong natural grouping already exists, so that in one or two districts the determination of one or two individuals to secure for themselves a factory would carry sufficient weight to induce their neighbours to join them. The main parts of the case have been discussed over and over again and much has been done to clear the way for combination and mutual help.

Probably the finest site for a factory lies in the neighbourhood of Willoughby Bay. In this district lies a fine unbroken expanse of cane land lying wonderfully level, and here are situated some of the finest sugar estates in the island. Five or six miles of tramway would tap a district easily capable of supplying canes for from 3,000 to 4,000 tons of sugar. In this neighbourhood there are many places which offer fine facilities for the erection of a factory and for the supply of canes. A good factory here, with an inexpensive tramway system, would be capable ultimately of dealing with upwards of one third of the island's crop.

Willoughby Bay itself will not permit the entry of large vessels, though a narrow channel with a minimum depth of 4 fathoms exists and might be easily improved for steamships. The bay, however, forms a very convenient spot, calm and sheltered, where the produce could be loaded into small craft or lighters for conveyance to the ships, which might lie off the mouth of the Bay.

Another fine site lies in the Bendal's Valley. Here there is a run of land capable of producing over 2,000 tons of sugar. The factory might be placed to advantage somewhere between the present Bendal's Works and Creek-side Bridge. The stream flowing through the valley would afford an ample water supply, and a simple tramway system would enable such a factory to draw a supply of canes from the surrounding districts; all the district from St. John's to Herberts, including Belmont, Briggins and Ottos, could be joined up without difficulty if the owners so wished. A branch of tramway might be projected into Blubber Valley on the other hand. Another line of tramway would connect the factory with the sea and shipping place. It is rather an open question whether it would be desirable to run this branch down to Five Islands Harbour or to St. John's Harbour. Under certain conditions, perhaps, the line would pass with advantage across the country lying between the factory and St. John's. A factory in this district would have no difficulty in securing canes for 3,000 tons of sugar, and in a short time it might be expected to expand to 4,000 tons and over.

A third factory might well be placed to the north of St. John's. A good site might be found on Gambles Estate or on the Land of the Wood or Friar's Mill. From this factory a line of tramway might run through Cassada Garden to Paynters Village with a branch to Carlisle's and Millar's: if necessary an extension of the line would bring in the canes of Tomlinson's Gunthorpe's, Donovan's and Cedar Hill. Another line could bring down the canes from the higher levels of Pope's Head: there would be no practical difficulty in running a line either

through Marble Hill to Langfords or between Dunbars and Cedar Valley: if this line were carefully graded it should bring the canes over a considerable portion of its length by gravity and so prove a cheap section to work.

In the neighbourhood of Parham a site could be found for a fourth factory capable of dealing with the canes of the district lying to the south and east of that town.

These are, I think, the main centres to which it will be safe to direct the sugar business of the island. There are many other sites that could be mentioned, but the selection of the final sites must depend upon the individuals who have the actual carrying of the plans and schemes into effect.

I am of opinion that the difficulties of the cane industry in the Leeward Islands will be best overcome by the substitution of several moderate sized factories with adequate machinery of the best type, in place of the existing imperfect mills and muscovado boiling-houses; and I think the conditions prevailing in the colony make success more certain if the muscovado estates are grouped around several factories, rather than that an attempt should be made to manufacture all the sugar of the colony in one or two large factories.

If such factories are desirable, we have to enquire how they are to be obtained. Capital must be raised, and capital to a large amount. It seems to me very desirable that those interested in the growth of the factory system should keep before their minds one fundamental fact— the interests of the factory owners and of the landowners must be identical; any success on one side must be made to confer its benefits upon the other. If this is not the case, there will be continual friction between the field and the factory, with consequent loss of confidence and efficiency. In the early stages of development, until the conditions have been well studied, and rules for guidance and practice laid down, it will be very important that there shall exist opportunities for adjustment, for providing for unforeseen contingencies and for smoothing over those minor difficulties which must arise when so great a change is made as this will involve.

Money may be found for the enterprise by inviting capitalists to invest their money in the erection and working of factories—provided certain stipulations can be made. I believe the conditions are sufficiently favourable to attract the notice of capitalists if an agitation is made to bring matters to their notice. If such a means of acquiring factories is adopted, there is some danger of separating the interests of the land and the factory. The growers of the canes will strive to gain all the advantages they can by requiring the maximum price for canes and the minimum quality; while the factory owners on the other hand will naturally endeavour to drive the best bargain they can. Such a method of working may lead to a condition of affairs as unremunerative to the colony as that existing to-day.

Some method may be found by which these difficulties may

be avoided, and I have no doubt whatever that if the owners of sugar properties are in earnest over the matter and will bestir themselves, they will find a way to secure capital to build factories and to improve their position in the sugar world. If the landowners are to derive the full benefits from the introduction of improved machinery, they must be prepared to run some risks and to make some sacrifices.

I would suggest that the end may be gained by the landowners of a district combining and issuing debentures for the purpose of building a factory: the profits of the factory to go towards the redemption of the debentures. As the profits admit of such a proceeding, a certain amount should be paid as interest, say 6 per cent.: any profits beyond this should be divided between the growers of the cane on the one hand and the fund for the redemption of the debentures on the other. The debentures should be redeemable at the end of a fixed period - 15 or 20 years appears a reasonable period. The debenture-holders should have a first lien on the factory, and the landowners should guarantee half the amount of the subscribed capital. As the debenture holders have a first lien on the factory and participate in the profits, it does not seem to me necessary to require the landowners to guarantee the full amount of the capital subscribed. But all this can only be accomplished by vigorous and united action on the part of the planters themselves.

Having obtained the capital, the business of the Company will best be worked by paid directors. I would suggest a board of five directors to be paid £100 a year each for their services to be elected as follows: two by the debenture holders, two by the associated growers, and one by the government in the event of a government guarantee being obtained. The directors must have control of the whole of the business of the Company, and appoint all officers and servants. They should be elected for three years, but at the end of that time be eligible for re-election. It will probably be found desirable to elect one of their number as managing director.

The associated growers should undertake to supply not less than a fixed quantity of cane per annum. For these the factory should pay say 10/ [or 11/] per ton delivered at the mill, a share of the profits to be given to the associated growers as explained below. The factory would purchase canes from other growers at rates to be agreed upon.

Interest on the debentures to the extent of 6 percent. should form a first charge on the profits of the factory, any sum remaining over and above that should be allotted to the sinking fund for redeeming the debentures to the extent of 6 per cent.; should there be an excess over that amount, it may be divided equally between the cane growers, the debenture holders and the sinking fund. It will be seen that the sinking fund is virtually a bonus to the cane growers, for at the end of say 15 years, when the debentures are paid off, the factory becomes the property of the associated growers.

As to the amount of capital required, it will be necessary

that actual estimates and specifications be prepared in order to ascertain this with any degree of accuracy.

For a 3,000 ton factory I suggest the following figures:—

Cost of factory including machinery and buildings	30,000
Tramways and waggons	6,000
Working capital	8,000
Total	£44,000

Such a scheme can only form an outline, the details of which would have to be filled in according to the circumstances attending every particular case. I am, however, of opinion that the problem of placing the sugar industry of the small colonies may be solved by the erection of a few comparatively small factories in well-chosen districts, the capital being raised by owners of estates, on some plan such as I have described, so that in a few years this capital may be repaid and the factory belong entirely to the sugar growers.

If the capital is not raised in this way, at the instance of, and with some security from, the landowners, it will probably have to be found by outside capitalists who have no interest in the land. Such a method as this cannot be expected to be as profitable and beneficial to the cane growers as one promoted and backed by themselves.

One argument seems conclusive. If the muscovado industry now can struggle on and even make ends meet, under similar conditions as regards cost of canes and prices of sugar, well-equipped factories must make handsome profits.

I have had the special circumstances of the colony of Antigua in my mind while sketching this outline. With slight modifications the same statements will hold good for St. Kitts and Nevis, where there are one or two districts whence a large supply of canes could be obtained at a reasonable cost.

DISCUSSION.

The President: Central Factories together with the discovery of new varieties of the sugar cane, are regarded as the only means of saving the sugar industry in the smaller West Indian islands. The papers read to-day have been prepared with the view of affording all possible information as to the necessity for Central Factories as well as the numerous advantages to be derived from them if started on right lines. They have existed for many years in British Guiana, Trinidad and St. Lucia. Indeed, wherever sugar is produced on a large scale, they are absolutely essential. We are extremely indebted to Mr. Watts. He has given us a most useful and practical paper in regard to the possibility of starting Central Factories in the Leeward Islands; and what he has stated also applies to Barbados and to St. Vincent. He possesses in so

marked a degree the confidence of the planters in Antigua and is so thoroughly acquainted with their circumstances, that I anticipate in that island, at least, the paper will be read with great interest. Also that it will prove most helpful in solving the difficulties that have hitherto stood in the way of starting Central Factories. As a useful supplement to Mr. Watts's paper, I now invite your attention to a paper prepared by Mr. Bovell on the cost of growing canes in Barbados. It is necessary to establish this point before steps can be taken to arrange the price at which canes are to be sold to the factories.

COST OF GROWING SUGAR CANES IN BARBADOS

In relation to the present process of manufacture and to that of a properly equipped Central Factory.

By J. R. Bovell, F.L.S., F.C.S.

The subject I have taken for this paper is the cost of growing canes in Barbados in relation to the present process of manufacture and to that of a properly equipped Central Factory.

In view of the fact that there is a likelihood of central factories being established in this colony, and that their success in a great measure depends on the cost at which canes can be grown and delivered to the factories, I will give a short account, so far as I have been able to ascertain, of the cost of growing canes in Barbados; then compare this with the sum the planter now receives for them under the present system of manufacture, and finally with what he would receive from a properly equipped factory, preferably on co-operative principles.

The data on which I have based my calculations have been obtained through the courtesy of the Hon. W. K. Chandler, the Master-in-Chancery, from the annual returns made to him by the Receivers; and from information kindly given me by private gentlemen, from the yearly "abstracts" on the working of their estates. I have for obvious reasons omitted the names of the estates.

As far as I can ascertain from the information at my command, the cost of growing and delivering canes at the present estate-works, may be placed on an average from about 13/ per ton, on 75% of the fairly good estates economically conducted, to 19/ on estates in what is known as the Scotland district, where, owing to the unsuitableness of the land and to other conditions, the cost is considerably higher than in other parts of the island.

On referring to Appendix A, it will be seen that I have estimated the cost of growing an acre of canes on a fairly good non-ratooning estate in the black soil districts, without taking into consideration the upkeep of roads and the necessary buildings, at $61.04 (£12 14. 4.) This divided by 22·44375 tons, the average yield on a similar estate for six years, makes the cost of producing a ton of canes about 11s. 4d.

In corroboration of my estimate of $61.04, I may mention that one gentleman, the proprietor of two estates, tells me he finds from his accounts that the cost of growing one acre of canes is about $62.50 (£13 0. 5.) Another gentleman of considerable experience, in the itemised estimate he has given me (Appendix A_2), considers it to be $65.30 (£13 12. 1.) per acre.

That these statements are fairly correct, may be gathered from the actual returns of two estates (*see* App. B. & C.). In the case of the first after allowance is made for the 20 per cent. reduction in wages etc., which has taken place since the years for which the returns are given, viz:– those from 1881 to 1885 inclusive, the cost is 12s. 3d. per ton, and in the case of the other the cost is 14s. 5½d. The difference in the first instance, is accounted for by the fact that only the cultural operations etc. absolutely necessary are given in my statement, and no allowance made for improvements and the upkeep of roads; and in the other instance, by the same cause, and also by the fact that the returns of the year in which the fungus disease and the drought wrought such havoc are included.

A further confirmation of the statement, that under existing circumstances canes are not grown *on the average* for less than 13/ per ton, may be seen by referring to Appendix D, in which is given the actual cost compiled from the Chancery Court returns, of producing a ton of canes on five estates for the years 1894, 1896, and 1897. The first four estates are representative of the typical districts of the island, and the years mentioned were chosen for the reason, that the average crop of the island for these three years, is approximately the same as the average for the ten years, 1880 to 1889 inclusive. These estates were also selected from the fact of their being worked under the Court for some years; there was, therefore, time for them to have recovered from the effects due to the probable want of funds for their proper cultivation, prior to their being put under the Court; consequently the average cost of 14s. 6¼d. per ton, omitting the estate in the Scotland district which is 19s. 1d. per ton, is probably somewhat near the average for the whole island.

Judging from the cost of producing canes in some of the

neighbouring colonies, which appears to be under 10/ per ton, it may be asked, why it is that the cost of growing canes in Barbados is so high. The reason is, that in other colonies, such as British Guiana and Trinidad, where there is plenty of unoccupied land, as a field shows signs of exhaustion its cultivation is discontinued, and the land allowed to lie fallow for some time. In Barbados, owing to the redundant population and the necessity of finding employment for them, this cannot be done; consequently the planters, to keep up the fertility of the soil, have to resort to large applications of both farmyard and chemical manures, these two items alone amounting in some instances to 6/ per ton of canes.

When in Trinidad in 1895, with the Emigration Committee, we were told of two instances, in which cane-farmers who had been paid 6/ per ton for their canes standing (*i.e.*, the planter paying cost of reaping and carting), made a profit. On visiting the farms and ascertaining full particulars, we found that the canes had been grown on lands that had lain fallow for about ten years; the yield being in one instance 35 tons and the other 36 tons per acre. According to the evidence given before the Royal West India Commission in 1897, since 1890 the cane growers in Egypt have been paid 14/ per ton, at which price the culture was profitable, indeed the most profitable in the country.

As most of the calculations in the Appendixes are based on the assumption that it takes 13½ tons of canes to make a ton of sugar, it may not be out of place here to show on what grounds this statement is made. In 1885 Mr. Jos. Connell, snr., then of Sandy Lane plantation, weighed and manufactured separately the canes from half an acre of land, with the result that 12 tons 17 cwts. 3 qrs. 2 lbs. were required to make one ton of sugar, from juice at 11° Beaumé. The same year, in an experiment conducted by a committee of the Agricultural Society at Jordans estate, it took with juice at 11.6° Beaumé 11 tons 2 cwts. 2 qrs. 5 lbs. of canes to the ton of sugar. Again in 1896, calculating the extraction of the mill at Bushy Park from the average of seven years experiments, and the weight of a gallon of juice on the polarisation of numerous samples of juice made during the reaping season, I found that it took 13·6 tons of Dodds canes that year, to make a ton of sugar. From the foregoing, it may, I think, be safely assumed that with canes containing juice of the normal saccharine richness, say at about 10° Beaumé, it takes 13½ tons to make a ton of sugar.

Having shown the approximate cost of growing a ton of canes, let us now ascertain what the planter gets for it at current prices, under the present system of manufacture. For some time during the last crop season, muscovado sugar sold for $1.75 per 100 lbs. plus $5.00 for the hogshead; and molasses at 11 cents per gallon, plus $4.00 per puncheon, being a total of $59.03, or £12 5s. 11½d. per ton with its molasses. At these rates, the value of a ton of canes, after deducting the cost of manufacture (say 5s. 5d.), would be 12s. 9½d.

It may be justly asked, how it is that some estates like

plantation (c) in Appendix D. are able to show a profit, when the planter only receives about as much for his canes as it costs to grow them. In this particular instance, the apparent profit realised from a ton of sugar, was £1 17. 7.; but the revenue derived from provisions, rents and miscellaneous receipts, was £1 19. 10½, so that, had the revenue been obtained solely from sugar and molasses, the estate would have lost money. The other estate, which really made a profit from sugar, was plantation (a): the amount realised, after deducting the revenue from other sources, was 19s. 8½d. per ton of sugar, or at 13½ tons of canes to the ton of sugar, 1s. 5½d. per ton of canes. The buildings on this estate, are, I am told, badly in need of repair, and it may, therefore, I think, be fairly assumed that, had the necessary repairs been effected, the profit would have been even less.

Having shown what it would cost the planter to grow his canes, and what he gets for them under the present process of manufacture, with sugar at $1.75 per 100lbs. and molasses at 11c. per gallon, I will now try and show what a properly equipped factory could afford to pay for them, when dark crystals are selling at $2.30 per 100lbs., that being the price they fetched last year when muscovado sugar sold at $1.75 per 100lbs.

Pre-supposing the factory to be a co-operative one, the planters could, according to the estimate I have prepared in Appendix F, be paid 15/ per ton of canes when dark crystals were at $2·30 per 100lbs. (£10 14s. 8d. per ton locally); and there would still be sufficient left to allow for depreciation and other necessary factory deductions.

That the price mentioned, viz., 15/, is fairly accurate, I may mention that at the Racecourse Sugar Mill Factory, Queensland, with an average crop for six years of 2,314 tons, and with the average price of sugar at £10 10s. 11¼d., the planters were paid 14s. 6¼d. per ton for their canes.

To briefly summarise, I may say:

(1.) That the average cost of producing canes in Barbados is about 13/ per ton.

(2.) That their value under the present system of manufacture, at the current rates for last season, is about 12s. 9½d. per ton.

(3.) That their value at a properly equipped co-operative central factory, at the average price for dark crystals for last season, is 15/ per ton.

That the cost of producing sugar in Barbados is high, in fact higher than in most colonies, will, I think, have to be admitted; and as there seems every likelihood that £10 14s. 8d. will be in the future rather nearer the maximum than the average price of sugar, every effort must be made to reduce the cost of production: while the Imperial Department of Agricul-

ture, will, I am confident, do all in its power to obtain canes of increased productiveness, both as regards saccharine richness and weight of canes per acre.

APPENDIX A.

Cost of cultivating one acre of cane land in Barbados.

(J. R. Bovell.)

	$ c.
Digging cane holes 1,742 @ 8c. per 100	1 39
Pecking cane holes	12
Applying pen manure	1 00
Digging manure holes	52
Bedding manure	35
Forking land 1,742 @ 8c. per 100	1 39
Weeding land 26 weeks @ 8c. per week	2 08
Cane plants @ 15c. per 100	2 61
Cutting plants @ 1c. per 100	17
Picking plants @ ½c. per 100	08
Dropping and planting cane plants	24
Draining land	2 16
Trashing canes @ 6c. per 100 holes	1 04
Applying artificial manure	24
Cutting out borer canes	24
Cutting, loading, and carting canes @ 20c. ...	3 48
Making cart paths	15
Weeding hedge rows	12
	$17 38
Farmyard manure	17 42
Artificial manure	16 24
*Management, overseer, accountant etc.... ...	6 00
Taxes	1 00
Insurance of canes	1 00
Sundries	2 00
	$61 04

* [The cost of management is here all charged to cultivation on the assumption that the same number of persons would be employed even if the canes were sold to a Central Factory.—Ed. W. I. B.]

APPENDIX A_2.

Statement of the cost of cultivating one acre of cane land by——

	$	c.
Digging cane holes 1,210 holes @ 8c. per 100 ...		97
Applying pen manure 2½ sqrs. @ 40c. per sq. ...	1	00
Digging manure holes 1,210 holes @ 3c. per 100 ...		36
Bedding manure 1,210 holes @ 2c. per 100 ...		24
Ploughing		30
Forking land 1,210 @ 8c. per 100	1	21
Weeding land 1 year	3	00
Cane plants	2	50
Picking plants		20
Dropping and planting cane plants		20
Draining land	2	16
Trashing canes 1,210 holes @ 6c. per 100 ...		72
Applying artificial manure		24
Cutting out borer canes		30
Cutting, loading, and carting canes 1,210 holes @ 25c.	3	02
Making cart paths...		30
	$16	72
Farmyard manure	24	00
Artificial manure	14	00
Management, overseer, accountant	6	00
Taxes	1	14
Insurance of canes	1	44
Sundries	2	00
	$65	30

APPENDIX A_3.

Statement showing the average number of acres planted at ——— Plantation and the Sugar Crop therefrom for the years 1891 to 1896.

Years.	Acreage planted.			Crop of Sugar.
	A.	R.	P.	Lbs.
1891	106	1	0	417,198
1892	104	2	0	365,257
1893	102	1	0	382,264
1894	98	2	1	454,648
1895	99	0	23	273,070
1896	91	0	18	348,781
Total ...	601	3	2	2,241,21
Average ...	100	1	7	373,536

Average yield of sugar per acre for 1891 to 1896 is 1·6625 tons per annum.

As it takes 13·5 tons of canes to make one ton of sugar, the average weight of canes per acre is 22·44375 tons.

The above estate spent in chemical manures on the average for the six years 1890 to 1895, $16.24 per acre per annum.

The cost of growing one acre of canes as per Appendix A, is $61.04. Consequently a ton of canes costs 11s. 4d. to produce.

APPENDIX B.

Statement showing cost of cultivating 1 acre of cane land, and the cost of producing 1 ton of canes at ——— Estate, for a period of five years.

	1881	1882	1883	1884	1885
	$ c.	$ c.	$ c.	$ c.	$ c.
Expenditure (Total) ...	10,119 60	9,223 51	9,246 38	11,214 04	8,997 35
Manufacturing Expenses	3,169 40	3,143 80	2,638 37	3,047 71	2,905 99
Cultivation Expenses ..	6,950 20	6,079 71	6,608 01	8,166 33	6,091 36

Average cultivation expenses for the years 1881 to 1885	$ 6,779·12
Less $\frac{1}{5}$ for the reduction in price of wages	1,355·82
	$ 5,423·30

$5,423·30 ÷ 75 (No. of acres in cane cultivation) = $ 72·31, the cost of cultivating 1 acre of cane land.

	Tons	cwt.	lbs.
Average sugar crops from 75 acres of land	136	11	18·4
Average production of sugar from 1 acre	1	16	11·8

As there are 13·5 tons of cane to 1 ton of sugar, therefore there are 1 ton 16 cwt. 11·8 lbs. × 13·5 tons of canes per acre = 24·5835 tons.

The cost of cultivating 1 acre of land as above is \$72·31, therefore \$72·31 ÷ 24·5835 = the cost of producing 1 ton of canes = \$2·94 or 12/3d.

APPENDIX B_2.

Statement showing the cost of manufacturing 1 ton of sugar at ---- Estate, for a period of five years.

Years.	Sugar Crops.			Net Manufacturing Expenses.	
	Tons	cwt.	lbs.	\$	c.
1881	122	18	3	3,169	40
1882	121	7	2	3,143	80
1883	152	0	2	2,638	37
1884	122	5	1	3,047	71
1885	164	8	0	2,905	99
Average	136	11	18·4	2,981	05

	Tons	cwt.	lbs.		
\$2,981.05 ÷	136	11	18·4	=	\$21·83
Less $\frac{1}{5}$ owing to the reduction in price of wages					4·36
Cost of manufacturing 1 ton of sugar				=	\$17·47

As it takes 13·5 tons of cane to make 1 ton of sugar, therefore \$17·47 ÷ 13·5 tons of cane = the cost of manufacturing 1 ton of canes = \$1.29 = 5s. 4½d.

APPENDIX C.

Average Receipts and Expenditure at .. Plantation for the years 1892 to 1896 inclusive.

Years.	Expenditure			Sugar Revenue.			Molasses Revenue.			Sundries Revenue including Potatoes Revenue.			Potatoes Revenue.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1892	2,349	19	11½	1,733	0	1	611	17	10	298	5	3½	85	16	11
1893	2,151	12	1½	2,363	11	1	468	8	10½	355	5	5½	176	13	6
1894	2,456	0	4	2,047	19	9½	526	0	8½	308	7	0½	161	7	4
1895	1,922	13	7½	1,021	15	8	371	7	10½	172	15	7	50	13	1½
1896	2,041	13	10½	1,527	1	4	420	7	11	306	18	10	181	7	11
Total	10,922	0	2	8,693	10	11½	2,398	3	2½	1,411	12	2½	655	18	9½
Average.	2,184	8	0⅖	1,738	14	2¼	479	12	7½	288	6	5	131	3	9½

	Tons	cwt.	qrs.	lbs.
Average crop, 5 years, 1892-1896 ..	162	17	0	20

	ac.	r.	po.	
Average acres of canes cut for 5 years, 1892-1896	102	0	21	or 102·13125 acres.

	Tons	cwt.	qrs.	lbs.
Average weight of sugar per acre	1	11	3	16 or 1·59464 tons.

Average weight of canes per acre 21·5277 tons.

Average cost of growing and manufacturing 1 acre of canes weighing 21·5277 tons is $102.66 or £21.7.9½.

Average cost of growing and manufacturing
1 ton of canes = $4.77 = 19s. 10½d.
Cost of manufacture, say 5s. 5 d.

Cost of growing one ton of canes ... .. 14s. 5½d.

APPENDIX D.

Average Revenue and Expenditure on certain Estates in the Court of Chancery for 1894, 1896, 1897. Average Crop of the Island for the 3 years—58,087 hhds., for ten years—1880-9, 59,620 hhds.

ESTATES.	(a).	(b).	(c).	(d).	(e).
	Tons.	Tons.	Tons.	Tons.	Tons.
Average Sugar Crop	370·334	82·408	118·579	70·041	118·652
	Gallons	Gallons	Gallons	Gallons	Gallons
Average Molasses Crop	37,122·6	8,449	12,243	7,461·3	12,543
Average quantity of molasses per ton of sugar	100·24	102·52	103·24	106·53	105·71
	$ c.	$ c.	$ c.	$ c.	$ c.
Revenue per ton of sugar	44 61	47 22	46 67	46 31	49 96
Revenue from molasses per ton of sugar	12 76	14 41	14 91	15 42	14 25
Revenue from provisions per ton of sugar	45	10	1 96	9 57	16
Revenue from Rents per ton of sugar	1 26	1 87	3 25	3 98	4 71
Revenue from other sources per ton of sugar	60	1 50	4 36	85	1 72
Total Revenue per ton of sugar ...	59 68	65 10	71 15	76 13	70 83
Expenditure on agriculture per ton of sugar	$ c. 19 19	$ c. 23 57	$ c. 30 33	$ c. 34 73	$ c. 31 04
Expenditure for cooperage and repairs per ton of sugar	6 15	8 34	6 42	9 35	7 90
Expenditure for utensils per ton of sugar	06	...	11	...	...
Expenditure for live stock and miscellaneous items per ton of sugar	3 57	3 11	1 46	4 82	3 23
Expenditure for tradesmen per ton of sugar	2 54	2 35	3 27	2 59	3 87
Expenditure on food for stock per ton of sugar.	2 77	3 20	2 38	2 95	4 56
Expenditure on manure per ton of sugar	9 77	11 96	5 18	4 89	13 82
Expenditure for fuel per ton of sugar	80	1 25	1 02	...	91
Expenditure for taxes and insurance per ton of sugar	1 80	3 07	3 96	4 26	4 03
Expenditure for salaries per ton of sugar	5 99	9 27	8 00	13 22	10 07
Total Expenditure per ton of sugar	52 61	66 12	62 13	76 81	79 43
	$ c.	$ c.	$ c.	$ c.	$ c.
Profit per ton of sugar	7 04	...	9 02	.	...
Loss per ton of sugar	...	1 02	...	68	8 60
Revenue from sugar and molasses per ton of canes @ 13·5 tons per ton of sugar	4 25	4 56	4 56	4 57	4 75½
Expenditure per ton of canes @ 13·5 tons per ton of sugar...	3 90	4 90	4 60	5 69	5 88
Average price at which sugar sold per 100 lbs.	1 77	1 86	1 89	1 80	2 00
Average price at which molasses sold per gallon	09	10	10¾	10¾	11
Revenue per ton of canes after deducting 5s. 5d. for manufacturing ...	2 95	3 26	3 26	3 27	3 45½
Expenditure per ton of canes after deducting 5s. 5d. for manufacturing	2 60	3 60	3 30	4 39	4 58

It would appear from the last line in the foregoing table that the actual cost of growing canes in Barbados (after a deduction of five shillings and five pence for the cost of manufacture, the upkeep of buildings, etc.,) was as follows :—

		s.	d.
Estate (a), St. James and St. Andrew	...	10	10
Estate (b), St. Joseph and St. Thomas	...	15	0
Estate (c), St. Philip ...	...	13	9
Estate (d), Christ Church ...	...	18	3½
Estate (e), Scotland District ..	...	19	1

APPENDIX E.

Statement showing the value of one ton of canes with manufacture as at present carried on.

On 25th April 1898, the price of dark crystals in the New York Market was $4\frac{5}{16}$ = £20 2s. 6d. per ton, less duty = £12 10s. 4½d.

At the time dark crystals were worth £12 10s. 4½d. free of duty, the local merchants were buying sugar @ $1.75 per 100lbs plus $5.00 per hhd., and molasses @ 11c. per gallon plus $4.00 per puncheon. The value of 1 ton sugar and 100 gallons of molasses would be

2240 × $1.75 per 100	=	$36·20
1 hhd.		5·00
100 gallons of molasses @ 11c.	=	11·00
1 puncheon		4·00
		$59·20
Less Polariscope test	5	
„ Gauging 1 pun. molasses	12	·17
		$59·03

$59.03 ÷ 13·5 tons of canes per ton of sugar with its molasses = $4.37 or 18s. 2½d.; less what it now costs for manufacture, coal, drying fuel, repairs to buildings and machinery and freight of sugar and molasses to Bridgetown etc., about 5s. 5d. per ton = 12s. 9½d., the value of a ton of canes under the present system of manufacture.

APPENDIX F.

Estimate of a year's working of a sugar factory making 10,000 tons in 100 working days.

Sale of 10,000 tons sugar @ £10 14s. 8d (av. price 1898)	£107,333	
Sale of Rum equal to 10/ per ton of sugar	5,000	£112,333
Cost of 95,000 tons of cane @ 14/	£66,500	
Railway freight on 95,000 tons of canes @ 1s. 6d...	7,125	
Cost of manufacturing 10,000 tons @ £2 4s. 4d.	22,160	
Interest on £125,000 at 3 °/。	3,750	
Interest on £125,000 at 3·72 °/。	4,650	104,185
		£ 8,148
Pro-rata division on 95,000 tons of canes @ 1/ per ton		4,750
Carried to Reserve Fund		£ 3,398

DISCUSSION.

The PRESIDENT: We should be glad to hear the views of Professor Harrison on the important matter now before the Conference. I can assure him his remarks will be highly appreciated.

PROFESSOR HARRISON: I said a good deal on this subject ten years ago, but, unfortunately, it had no effect. There is not the slightest doubt in my mind that, if this Colony of Barbados is to continue to exist as a sugar-producing colony, it must adopt the principle of Central Factories. When I was asked by the West India Royal Commission my opinion as to the effect of Central Factories on Barbados, I said that, if the planters there had Central Factories, they would not have time to talk about bounties. I believe the advantages that would be derived from manufacturing sugar on modern lines would be such as to place the sugar industry in this Island on a most satisfactory footing. I am not prepared to go into details, because during the last nine years there has been no necessity for me to study the question as there are plenty of such factories at Demerara. Mr. Watts has laid the matter fully before us, and I can only say his remarks with regard to Antigua are very applicable to this Colony. I think he some-

what underrates the expression of the mills in this Colony. My own opinion is that the mills here, although small, are effective. In 1884 we went into the question thoroughly, and we were able to ascertain the comparative results of the muscovado process. These results were undoubtedly favourable to that process, but, I may add, in that year the canes were abnormally rich. I cannot say much more, for I am really not prepared to enter into the subject to-day. All I can say is, that I believe the erection of Central Factories in Barbados would be the means of raising the Colony out of its present difficult position, and, in fact, would prove its salvation.

The PRESIDENT: In reply to a remark dropped by Professor Harrison whether the question of the manufacture of sugar fell within the province of this Conference, I would state at once that it is proposed to deal as effectively as possible with every subject of a technical character, directly or indirectly bearing upon agricultural industries in the West Indies.

Mr. WATTS: The cost of raising canes is a fundamental one, for on it depends whether the planter makes a profit or loss. I have not time to go over Mr. Bovell's figures, but it strikes me that the high rate at which he has placed the cost of growing canes in Barbados is not consistent with the official statement placed by the Committee of planters before the Royal Commission. It was then stated that it cost £9 16. 2. to produce a ton of sugar. If that amount is divided by thirteen and a half (the number of tons of canes to a ton of sugar), a very small margin would be left for the cost of manufacture. It is possible, therefore, that Mr. Bovell's figures will bear a little pruning.

Mr. BOVELL: I may say that my figures are taken from the Receivers' accounts in the hands of the Master-in-Chancery, sworn as correct. I have made all necessary deductions and bring out the cost of growing canes at 12/- per ton. This, I believe, is the cost of producing 75 per cent. of the canes grown in this island. The cost of manufacturing into sugar is about 5s. 5d. per ton.

The PRESIDENT: Mr. Bovell's figures seem very high, but there is, apparently, no one present in a position to correct them. It is possible that a higher price could be paid for canes in this island because of their greater richness in sugar. It must also be borne in mind that even under the muscovado system, (taking the average prices of the last five years) the planter at present realizes at least 12/6 per ton for his canes. At a well-equipped Central Factory it would be possible to realize a still higher value. The necessity of the hour is evidently Central Factories.

The Conference then stood adjourned until Monday morning at 9 o'clock.

SECOND DAY.

The Conference resumed at 9 o'clock on Monday, the 9th January.

The PRESIDENT: To-day we are first of all to consider the very important subject of the teaching of Agricultural Science. It would be convenient to separate the subject into its two natural divisions—(1) teaching Agricultural Science in Elementary Schools; and (2) teaching it in the Secondary Schools and Colleges. The Rev. W. Simms of the High School, Jamaica, has been kind enough to prepare a general paper on the teaching of Agricultural Science and he will deal with the various agencies that have been employed for that purpose in various parts of the world. After the paper, we shall confine ourselves to the teaching of Agricultural Science in Elementary Schools and hear the views of gentlemen practically engaged in elementary education. After that we shall discuss the further development of Agricultural Education in connection with Secondary Schools and Colleges. We are fortunate in having present here to-day the heads of five of the largest and most important Colleges in the West Indies. I hope these gentlemen, having come so far, will favour us fully with their views as to what is possible to be done at the institutions under their charge. Before calling upon Mr. Simms, I may mention that he has been lately deputed by the Education Board of Jamaica to visit the United States and Canada to study the methods there carried on for teaching agriculture, and on his return he wrote a valuable and detailed Report. He, therefore, approaches the subject with considerable knowledge, both practical and theoretical, and the paper which he has been good enough to prepare for us to-day will be listened to with great interest.

AGRICULTURAL EDUCATION.

By the Revd. WILLIAM SIMMS, M.A.

The shortness of the time at our disposal compels me to be brief, but with an audience like the present, much may be taken for granted. If brevity makes me obscure, or any of my assumptions seem disputable, the discussion to follow this paper will give opportunity for filling gaps and correcting errors. It is well too to premise that my experience of West Indian conditions is exclusively of those in Jamaica, which must in some respects differ from the other Colonies, and that my statements and arguments have in mind discussions that have arisen in Jamaica, and may accordingly in some cases seem needless to those who have not gone through the same discussions.

I will begin with what seem to me the axiomatic truths,

on which our consideration of the subject of Agricultural Education in the West Indies must be based. They are as follows:—

1. Agriculture is, and must continue to be, the occupation of the large majority of the people of these Islands.

2. Other occupations both of brainworkers and of handworkers must exist side by side with that of agriculture.

3. Education must not simply look to the future occupation, but must aim at producing a capable citizen able to adjust himself not only to his own calling but to the moral, political and social activities of the life around him.

4. Education is in a transition state. Two or three generations ago the working class, not only in the West Indies, but almost everywhere throughout the world, early entered without education on a life of grinding toil, whilst the middle class passed through a period of apprenticeship to their future calling after leaving school; whereas now the working class is to be educated: and, the apprenticeship system having passed away, the school is called upon to do what that system did in the way of preparation for the future life.

5. Educationists are now agreed that education has rested too exclusively on books, and that, quite apart from any consideration of its utility on the apprenticeship side, some manual and practical training is essential to the complete education of the citizen.

6. It is impossible for children to receive technical education to any advantage, or indeed to take it in at all, until they have reached the age of twelve and got a basis of sound elementary education. Their apperceptive faculties are not equal to the strain. Elementary schools in the West Indies at present find this educational basis more than they can successfully attain.

7. No subject can be really educational unless and until its teaching is reduced to proper pedagogic methods.

8. Agricultural training is at present, even in more advanced countries such as Germany and the United States, in the tentative stage, and there is a great scarcity of proper educational text-books on the subject fit for school use.

9. Technical education is necessarily more expensive than book education: the numerical proportion of teachers to taught must be much greater, buildings and material of all sorts more expensive, and, at present at any rate, the pay of competent teachers higher.

10. Secondary schools must continue their present work of educating the professional classes, and must continue to meet the educational requirements of the University and other examining Boards which practically settle the preliminary education of those classes. In Jamaica at least, the large majority of the pupils in these schools do now require and will in the immediate future continue to require this training.

11. The time tables of these schools are very over-weighted already, and new subjects can only be added by reducing some of those at present taught.

12. In small schools, such as nearly all those in the West Indies must continue to be, the necessarily limited staff can only teach a limited number of subjects, whether we consider the acquirements of the teachers or the calls upon their time. Boys who drop some of the usual subjects taught to the majority, and require new ones in their place, must necessitate an increase of staff.

13. It is a great mistake to introduce a subject suddenly into the schools until you have teachers fit to teach it. A new subject must, therefore, be introduced at first on a small scale, and its teaching must grow gradually.

These axioms will, I think, be universally admitted by all who have a competent knowledge of the subject; but the real difficulty lies in the *axiomata media*, in the practical application, in finding the line of least resistance among conflicting truths and claims. Before attempting to deduce a system from the axioms laid down, I proceed to inquire how far we can be helped inductively by observation of what is done in other countries. Here time forbids anything but a brief statement of the main facts.

In England in the Elementary Schools, agriculture is now a specific subject; very few schools take it up, and most of those do very poorly. In the year 1895, only 24 students in the Training Colleges took it up. In the evening Continuation Schools, it is taken up by very few pupils. There are two or three old-established Agricultural Colleges like that at Cirencester which give an elaborate and expensive education. The County Councils are taking up the subject and in the agricultural counties have in some cases established Farm Schools for boys over 16 and young men; they have helped the Secondary Schools by supplying them with laboratories and helping to pay a teacher in Agriculture or more commonly in Agricultural Chemistry; they have also tried to train the Elementary School teachers and give a good deal of itinerant teaching, principally in dairy work.

In the United States the Agricultural Colleges are all connected with Experimental Stations: they give a four years' course to a very few students, most of whom become teachers, lecturers, newspaper writers, &c., and very few actually take to farming. There are short courses varying in length from a few weeks to two years, which attract a considerable number of the farmers and are leavening practical work. In the Elementary Schools there was in 1896 no practical work (I was told this by the Commissioner of Education for the United States), and only here and there any attempt at theoretical teaching. I learn from the Secretary of Agriculture's report for 1898 that an attempt made by Cornell University to test the Common Schools in Northern New York, of which I saw the beginning, is to some extent succeeding. They hold strongly that you cannot make a good agriculturist or anything else

of an uneducated man: that the children need all their time for other work, and are too young to take up this subject with advantage. I learn from the same report that there is no agricultural teaching in the Secondary Schools, but that the Department has applied for an additional grant in order to make an attempt at giving it. One or two of the Colleges (*e.g.* the one in Minnesota) have Farm Schools attached to them: but the students are all above 16. An attempt made by Mr. Booker T. Washington, at Tuskegee in Alabama, to give the coloured people an education based on practical teaching, is exciting considerable attention, and is so far considered a success.

In Canada the College at Guelph is a highly successful school for youths whose ages vary from 16 to 25; it also gives short courses to large numbers of farmers and their wives and families. Agriculture is in Ontario a possible subject of teaching in the Training Colleges and in the highest classes in the Elementary Schools; but is not often taken, the farmers, who in the rural districts, govern the schools, thinking that they can teach the subject better than the elementary teacher. In the High Schools, Agricultural Chemistry is a subject which may be taught, but practically is very rarely or never taught. No other agricultural subject is taught at all.

In Prussia there is no agricultural teaching in the Elementary Schools. It is taught theoretically in the evening Continuation Schools, but is taken up by very few students. It is not mentioned in the Elementary School Code, and the object lessons in specifying plants mention tea, sugar cane, &c., rather than those cultivated in Prussia. Agriculture is not a subject in the *Realschulen* or *Operrealschulen*. There are some Agricultural Schools and Schools of Forestry, &c.

In France agricultural education is given in the Elementary Schools, mainly theoretical but with experiments in pots and boxes. In the field or garden, where possible, all may take a part in watering and weeding and in observation of tools, treatment of soil, rotation of crops, and the effect of tillage and fertilizers; and a few of the older children in grafting, &c.

In Ireland the subject has been taught theoretically in the Elementary Schools to some extent, and somewhat more than one per cent. of the schools have opportunities for practical teaching in farms or gardens. Except in these schools the witnesses before a recent Commission considered it a failure.

In Scotland Professor Wallace and other agricultural authorities discourage all teaching in the Elementary Schools beyond theoretical teaching with pot and box and small plot experiments.

These facts justify my statement that the whole subject of agricultural teaching is at present only in the tentative stage, and is only in process of being reduced to a form in which it can be beneficially taught. The want of text-books on pedagogic lines is being complained of in every college that I visited in the

United States and Canada. As a matter of fact, there is a general feeling that something ought to be done: a good deal has been done in collegiate agricultural teaching, but practically very little else—a little on the Guelph lines, but hardly anything in the ordinary elementary or secondary schools.

What are we to do in the West Indies? What in our Training Colleges and Elementary Schools? What in our Secondary and High Schools? What for the population generally? In Jamaica the Board of Education has had two Tropical Readers drawn up, which are being gradually introduced into the higher classes in our Elementary Schools (and which I use for the Elementary Science Lesson in the lowest class in the High School). It has further given grants for elementary theoretical teaching illustrated *(a)* by pot and box experiments, and *(b)* by actual plot culture. Very few schools have applied for grants under either head.

A Commission which has been sitting in Jamaica for some time and has just reported, advises that agricultural instruction should be given to boys and to girls. "The objects should be to give sound theoretical and practical teaching: to help them to earn their living: to teach them that there is scope for trained intelligence in agriculture; and to create a taste for agriculture: it should be practical and not laborious, and should have special reference to the products of the district in which the school is situated. It should only be given in schools in which the teacher has been trained in the subject, and should be confined to the ordinary school hours for one hour a day or for four hours a week at least. Theoretical teaching should be by object lessons and demonstrations in the simple principles of plant life.

"Practical teaching (1) should be on a small piece of land adjoining or near the school; (2) or, if this is not possible, in boxes and pots: (3) should not be field work, and the teacher should *(a)* set the example and work with his own hands, *(b)* make the children familiar with the use of implements, and *(c)* explain the reason for every operation."

One of the Superintendents in the Department of Public Gardens has been set free from most of his departmental duties (has been seconded, if one may use the military phrase), to act as Instructor to the boys of an Industrial School on the Garden lands, and to give practical lessons to small settlers throughout the country. The Agricultural Society assists financially in this arrangemnt, and he is frequently accompanied on his teaching tours by its Secretary. The Jamaica High School is close to the principal station of the Botanical Department, and I have made arrangements with Mr. Fawcett by which boys at the High School, dropping some of our school subjects, may receive two hours teaching daily by lecture and practical work in the Gardens under this gentleman or substitutes during his absence on his country tours. Only one boy has applied to take this course, but the number may very possibly increase when we get actually to work.

I think I shall best make my own recommendations definite

by saying what I think should be done in Jamaica, leaving others to apply the principles, so far as they commend themselves to the Conference, to the different circumstances of the other Colonies.

I think that the whole agricultural teaching in any one of those Colonies should centre round an Experimental Station, to which should be attached an agriculturist who would conduct the actual work of the Station, and give lectures and practical lessons on agricultural subjects; the Island Agricultural Chemist should have certain definite duties both of teaching and experimental work in connection with the Station, being given an Assistant to help him in this part of his work; the head of the Department of Public Gardens would be Director, acting as Chairman of the Station Board, and Lecturer on Economic Botany; the Station could probably also obtain lectures on agricultural entomology, insecticides, fungicides, etc., from the Curator of the Jamaica Institute. The Station, if it is to have the services of these officers, and to be able to do its teaching work, must necessarily be within the area communicating with Kingston and the Public Gardens by the electric car lines, although this district is on the experimental side not a very good one. As time went on, students trained at it could become resident heads, experimenters and teachers in subsidiary stations under the direction of the staff of the chief Station, fixing the places of such stations so as at once to serve the chief centres of population and to attain the desideratum of being under different cultural conditions and also different climatic conditions of elevation, rainfall, &c. An attempt should also be made on a system similar to that worked in Ontario and in the counties of Northumberland and Durham in England, to enlist the services of practical agriculturists at proper points in the Island as assistant experimenters. I do not think that such a station could at present give any complete collegiate course of agricultural teaching. It should offer teaching to boys from the Secondary or High Schools, who could reach it, and who would need a few hours only each week, and should also give to the students in the Training Colleges in or near Kingston courses of a slightly different nature, which might be given either for a few hours each week during the whole of their period of training or continuously for a few weeks at one period or possibly two periods during their course. There might also be students, including any holders of agricultural Scholarships, residing possibly at University College, or allowed to make their own boarding arrangements, who would receive the entire teaching given to the schoolboys, but give a much longer time to practical work on the Station. The holders of Agricultural Scholarships should be required to reside in the College, and give half their time or more to agricultural teaching, and help to other subjects, as is done in America. The teaching should include questions of the treatment of our products, of storage, packing and carriage, as well as of cultivation. Teachers actually engaged in teaching might, as in Ireland and some American States, be allowed to close their schools whilst attending a short course open to the Training College students.

It should be clearly understood that a short course would

do very little good indeed, unless the student was already acquainted with the ordinary agricultural methods, and that any training in scientific agriculture given at a Station postulates previous or contemporaneous practice on an ordinary estate or pen carried on for profit. The course given to teachers or Training College students should be directed to showing them what to teach to elementary school children, how to teach it, and how to illustrate it; and not to making them complete agriculturists.

With regard to the teaching in Elementary Schools, whether we consider the laws of the growth of the child's mind, or the number that could be usefully supervised in practical work by a single teacher, the pot and box demonstration teaching might be given to all, but the practical plot teaching should be given only to a few of the older and more advanced children, say in their last year at school; and, in the ordinary single-teacher school, should be given at a time when the rest of the school was not in session. This latter limitation would be needless in a large school where a teacher could be set apart for this work, whilst others were conducting the rest of the school. I believe that any attempt to teach children by means of an agriculturist who is not a trained teacher, would fail. Such a person might help a teacher, so that the latter could take a few, not many, more at a time; but for the moral effect on the children, it would be essential that the teacher should himself lead in doing the work.

This scheme leaves much to be filled in as time goes on; but I do not believe that more can be done as a beginning, and my own study and observation lead me to believe that this is the best beginning, on which any desirable and possible expansion can be based. The Station would also, not at first but gradually, absorb the present attempts to teach the peasant proprietors into a more developed system of the nature of the Farmers' Institutes in Ontario or Wisconsin or elsewhere. At first it would leave them exactly on their present basis. Our higher agricultural teachers must be for many years obtained from without. The future planter, penkeeper or overseer could receive instruction as a schoolboy, or later as an agricultural student. The teaching in the Elementary Schools will only gradually become at the same time practically and theoretically correct as the students trained in the short courses at the Station take charge of schools. In ten years I believe that, even without any growth in the station itself, it would revolutionize the teaching in the Elementary Schools; it would also have taught many practical agriculturists, and have diffused a mass of information by means of the results of its experiments, which would enormously improve our agricultural products both as to quantity and quality, and be a factor in the regeneration of these Colonies. I think such a method infinitely preferable to the mere attaching of a single instructor exclusively to any one of our existing schools or colleges. The boy at a Secondary or High School who needs such teaching, would get it without disturbing the training of his comrade, who is going to take up a profession, and would get it more efficiently

than it could be given by a single teacher. The science teaching all through the High School could be given by the Instructor of the Station, say for two hours a week, and bear on agriculture, whether on its physical, chemical or biological side. The Agricultural students, who would be among the older boys, would give about half their time to purely agricultural subjects, including work in the chemical and physical laboratory, and work in the field, which would be taught by the Station staff, receiving the rest of their teaching from the school staff, and dropping ancient languages and some other subjects. Much of the agricultural work of the Colony would enter into relations with the Station which would be impossible in the case of a school. The school teaching could only expand in the direction of training higher teachers by long courses; whereas, the Station could expand not only on this side, but also on any other where experience shewed that growth was needed.

I think I have been more practical by trying to solve the Jamaica problem, the conditions of which I know, and leave others to solve the problem elsewhere *mutatis mutandis*, only suggesting that a group of Islands easily accessible to one another could join to have a single Central Station, having as soon as possible the subsidiary Stations (which, I have expected, will grow up in the country districts of Jamaica), located in each Island of the group. I have made no suggestion beyond that as to the Director of the Station, as to points of government and other details; though I have in my mind the solution of such problems of detail on the lines adopted in the American Agricultural Colleges and Experimental Stations, which are nearly everywhere twin institutions worked together, the Station being subsidised by the Federal Government, and the Colleges by the separate States, the members of the staff of the Station being generally Professors in the College.

My suggestions, if carried out, would attain the following educational objects. Among the boys at Secondary Schools in the Kingston area—probably two-thirds of the total number at such schools in the Island—those who required it could get a fairly complete agricultural education so far as it is wanted by the ordinary farmer class. The students at the Training Colleges would be prepared to give in the Elementary Schools the teaching required by the labourer class, whilst the Industrial School system might be so worked as to give a fairly complete course of teaching of the labourer sort. I should deprecate any attempt to force agricultural teaching, beyond the elements I have mentioned, on all High School boys, as well as the idea that it is practicable on any possible financial basis to give practical training to any but a few of the best children in the Elementary Schools.

DISCUSSION.

THE PRESIDENT: The Rev. Mr. Simms's paper, as was anticipated, has proved both valuable and interesting. When print-

ed and circulated, it should lead to a thorough grasp of the difficulties to be faced in dealing with agricultural teaching in the West Indies. It is undecided yet how far it may be possible to carry on this work either in Elementary Schools or in Colleges. The subject is, however, ripe for discussion.

Mr. R. GERVASE BUSHE (Inspector of Schools, Trinidad): I do not propose to enter into any general discussion of the principles of this subject. Mr. Simms has stated them in a way with which I thoroughly agree. The question of instructing the children in Elementary Schools in Agricultural Science is at present engaging the attention of the Board of Education in Trinidad. The existing law regulating elementary education dates from 1890, and under it the Board of Education has power to attach land, and it contemplates the introduction into these schools of the teaching of Agricultural Science. There has been a feeling for years that something ought to be done in that direction, and, although the topic has been discussed from time to time, nothing practical has yet been done. About a year ago a Committee was appointed by the Agricultural Society of Trinidad to consider the question of Agricultural Instruction. The recommendations contained in their Report, which was referred to me by the Governor, seemed admirable. They indicated very clearly the lines on which success was likely to be attained. The recommendations of the Report were as follows:-

(1.) That Paul Bert's "First Year of Scientific Knowledge" and Blackie's "Tropical Readers" should be used in the schools.

(2.) That these "Tropical Readers" should be supplemented by papers and lessons prepared locally, and that the pupil should be examined annually in the subjects prescribed therein.

(3.) That an approved Text-book on Agriculture should be provided, and that there should be a special grant for the teaching of Agriculture from such text-book.

(4.) That there should be an additional grant for schools which properly maintain example or experimental plots.

(5.) That the grants for Agricultural teaching should be in all cases calculated on the number of pupils who pass satisfactorily the annual examinations.

(6.) That with a view of training teachers for the work proposed to be allotted to them, and of qualifying them to obtain these special grants, a Teachers' course of theoretical and practical instruction in Agricultural Chemistry should be given at the Government Laboratory, and in Botany, Horticulture and allied subjects at the Botanic Gardens.

The further consideration of these recommendations was postponed by the Board of Education till after this Conference.

They seem to agree with what, I understand, is proposed to be done by the Imperial Department of Agriculture. I do not see how we can make much progress unless something in the nature of these recommendations is adopted. The Trinidad Board of Education is anxious to co-operate with the Imperial Department in trying as far as possible to afford agricultural instruction in elementary schools. The most important points to be immediately considered are the use of suitable books, and proper instruction, theoretical and practical, given by capable teachers. In Belgium it was found that there had been a great difference in the results obtained in different parts of the country; the chief cause of success found there was due to the enthusiasm which individual teachers carried into the subject. Therefore, until we obtain a suitable plan of instruction for teachers, it is, I think, useless to attempt systematic teaching of agriculture in elementary schools. There is another point which Mr. Simms noticed but which is often lost sight of – the age of children in elementary schools. The majority of children do not remain until the full age, twelve years. I do not see how any practical instruction can be given below that age.

THE PRESIDENT: Mr. Bushe has practically narrowed the question down to two points trained teachers and suitable text-books for use in schools. It is evident that we must begin with the teachers. Later on the teachers would receive their training at the colleges: but as we wish to begin at once, it is necessary to take the present teachers in hand and make them as useful as we can. The idea is that a certain number of the most promising teachers might be brought into the chief town during their holidays for a course of lectures and training and spend a portion of each afternoon at the nearest Botanic Station for practical work illustrating the morning's instruction. Teachers who satisfactorily complete the course might have their out-of-pocket expenses paid. The question of text-books is, I think, practically settled by Blackie's "Tropical Readers." Later other books might be used. As a further stage, school gardens might be established where both teachers and pupils might cultivate the most useful economic plants suitable for the district. We must be prepared to meet with difficulties in starting work of this kind. Parents, especially the better class of black people, dislike their children being put to do agricultural work of any kind. We must try and overcome that by interesting the children in agriculture and familiarizing them with plant life.

Rev. J. E. REECE (Barbados): Four difficulties, I think, present themselves to us in considering this scheme for Agricultural Education. The first is expense. Perhaps the members of this Conference are not aware that here in Barbados we have a fixed sum for Elementary Education. The House of Assembly have limited the expenditure under this head to £11,000; and at the present moment we find it exceedingly difficult to make that sum do all that we require. In fact during the past year we have had to make reductions in the stipends of teachers to keep within the £11,000 granted by the Legislature. Therefore the first difficulty has to do with the cost of

carrying out the proposed scheme. The next difficulty arises from the want of suitable text-books. We have no books in our schools that would be of any use in teaching the subject; but this difficulty may be got over by the introduction of Blackie's "Tropical Readers," which Dr. Morris recommends, and which, we hear, are in use in the Elementary Schools of Jamaica. I have not seen these Readers, but if the Department contemplates drawing up special text-books for this purpose, I think that extracts from Dr. Nicholls's excellent work entitled "Tropical Agriculture," might with advantage be included in a text-book for use in our Elementary Schools. The third difficulty is: We have no teachers at present who could give instruction in this subject; they must, as has been said by you, Sir, first be taught. It is intended, it appears, to surmount this difficulty, by asking certain teachers to attend, during their school holidays, a course of lectures to be given by experts on such subject as would be suitable for the instruction of our elementary school children. The fourth difficulty is one which may be felt more here in Barbados than in any other West Indian Colony. It is the very great difficulty that will be experienced in getting any land near our schoolhouses where practical instruction may be given. Pot and box cultivation may be useful in giving some idea of the raising of small flowering plants, and in creating an interest in gardening. But I think for the purpose of teaching this subject practically, we ought to have plots of land attached to our schools in which the plants most generally grown in our Island may be cultivated; and I know, from the difficulty which we experience in getting play grounds, that the difficulty will be very great indeed. Many parents, too, as has been already stated by the President, will object to the practical teaching of agriculture to their children for the reason that this employment will soil their clothes. No doubt in time many, if not all, of these difficulties will be got rid of. I am perfectly in sympathy with the scheme; and I may state that when our Board of Education were last year drawing up new rules, we inserted a rule providing for a grant to be made to a teacher for passes in what we call "useful occupations," and this rule was framed with the hope that we might in the near future get certain useful things taught, such as cottage gardening, carpentry, and so forth—in fact, anything that the managers of a school together with the teacher might arrange to be taught. We also intend in future examining our teachers when they sit for the certificate examination in some text-book on agricultural science: and in the syllabus lately drawn up on the subject "The Principles of Agriculture" is set down for second year teachers. We shall be glad of your advice, Mr. President, in determining on the text-book to be used by our teachers in preparing for examination in this subject. I agree with Mr. Simms as to the age at which children should begin their instruction in this subject. In our Infant Schools we have object lessons given, and we make it a point that the objects shall include for the most part the animals we have in the West Indies, and tropical trees and plants. This instruction would suffice for children in Infant Schools. In

Primary Schools we have no object lessons, but we might introduce the approved text-book on agricultural science, which, I hope, is well-illustrated and interesting. The children in the Elementary Schools in this Island in the past have been at a great disadvantage in not having illustrated reading books. Their first reading book was the New Testament, and when they could read this well, they then used the Bible as their reading book, and when they could read the Bible fluently, they used the Irish National Fifth Book—a book not understood by them, and one not illustrated, and, therefore, uninteresting to them. It is only within the last ten or twelve years that illustrated reading books have been in use in our schools. I agree, too, with what Mr. Simms said in his paper with regard to the teacher of the school himself teaching this subject of agricultural science. I do not think much good would accrue if an outsider, however expert, were brought in to give a lesson, say, once a week. The children would be apt to regard it as an opportunity for playing a few pranks when their master's eye was not on them, rather than the opportunity of acquiring knowledge of a particular kind. I know very well from my own experience as a schoolmaster in what light boys regard the hour when the French master gives a lesson to them—they expect to have a merry time; and I am afraid that if an instructor in agricultural science were brought into a school to teach this subject, the children would take an opportunity of playing rather than of learning. So I thing it is absolutely necessary that the teachers themselves should conduct these classes. If, then, the expenditure can be met, and our teachers are taught and we have a suitable text-book, I do not see why some sort of agricultural education should not be given in our elementary schools: and if we can in addition get experimental garden plots, so that the teaching may be made practical, I am of opinion that the carrying out of this scheme would be of benefit to the Island.

MR. J. A. POTBURY: An attempt was made some time ago in British Guiana to introduce the teaching of Agriculture into elementary schools, and at the same time to induce the teachers to take up the study of agriculture scientifically. The subject was introduced into the syllabus of the teachers' certificate examinations, and, I believe, for the last five or six years it has been one of the subjects regularly taken up. It was intended to be compulsory, but so far it is voluntary. I think fifty per cent. of the teachers may have taken up the subject, but, only three schools have introduced it practically as far as I am aware. There is one school plot in each of the three counties Berbice, Demerara and Essequibo. In spite of the example set by the manager of the schools, who did all he could to inspire interest in the cultivatian of the plot, parents strongly objected to their children being taught agriculture and even threatened to take them away unless the subject was dropped. Perhaps they do not altogether believe in the powers of the teacher to instruct their children properly. At one school in the interior of the Colony, the teaching of agriculture has been carried on with fair success. The children grow coffee and cacao on the ground in the neighbourhood of the school. Perhaps they

are better off than others in having a good plot of ground for practical instruction. I do not think there would be any difficulty in Demerara in getting land. Indeed land would be willingly given in most places by the owners in the neighbourhood of the schools. I only hope that as one of the results of this Conference something effective may be done in the cause of agricultural instruction.

PROFESSOR P. CARMODY: As I happen to be the Chairman of the sub-committee that sent in the report to the Education Board of Trinidad, to which Mr. Bushe referred, I should like to mention a few of the ideas which we had in our mind when drawing up that report. As far as Trinidad is concerned, the report is not new. It is almost identical with a report sent in nine years ago; but the question of expenditure arose and the report remained on the shelves of the Secretary of the Department. The next time we moved in the matter, it was a question of schoolmasters. We found that we were manufacturing doctors and barristers (beyond the present requirements of the Colony), by means of four scholarships in connexion with our college education; and we came to the conclusion that if we could devote some of this fund to agricultural scholarships, we might meet the Government on the question of expenditure. The Agricultural Society took up the subject, and the report is the result of the consideration of the sub-committee appointed by the Society. The matter was before the Board of Education awaiting my return from England. Had I been in the Colony, some steps might already have been taken in the direction recommended, as our present Governor is anxious to push matters. As it is, we now await the result of this Conference. As regards teachers, we have gone carefully into the question and have come to the conclusion that, by means of the institutions which we already possess in the Colony, we would be able to impart instruction to teachers to qualify them for teaching the agriculture which we require to be taught in elementary schools. We wish it to be understood that we do not want agricultural education to take the place of the practical instruction which grown up children and men can obtain on the estates. There they can get far better than we can give in schools. We would only desire to prepare them for the practical part, and with that object we intend as a first course instructing teachers in Agricultural Chemistry at the Government Laboratory and in Botany at the Botanical Gardens, and teaching them the contents of a specified text-book. Then we would pass to a more advanced scheme for a second course, and to a still more advanced one for a university course. For the first year, however, we would confine the examination to the contents of the particular text-book. We want the teachers to be compensated for the additional trouble and expense in coming up to receive this instruction during their holidays. Our idea is to follow the principle adopted in Jamaica. We would pay the teachers on certificates we would grant them; and we would in addition pay them on the results of the system, they receiving so much of the grant on every child who passed the examination at the end of the year. The teacher's income would be proportionate to the energy he

threw into his work. The next consideration was a text-book. Having found Nicholls's "Tropical Agriculture" an excellent text-book, we proposed that it should be adopted in schools, not, however, as a book on agriculture but simply as a reading book, to turn the bent of the boys' mind towards agriculture. As far as we can foresee and we have given the subject eight or nine years' consideration there should be no difficulty in carrying out our scheme in Trinidad, but for this question of expenditure. Our educational expenditure is already very high. The vote for present subjects might have to be reduced if we intend to introduce agriculture: but it is doubtful whether any of the subjects now taught could be curtailed, there being so few. At any rate, we feel that, until the question of primary school education is settled, there is no use talking about agricultural colleges. If there is no demand for such colleges, we had better not have them at all.

The Rev. CANON BINDLEY: One point that has borne in upon me whilst listening to the discussion this morning is whether we are not rather putting the cart before the horse in speaking of teaching agriculture in our elementary schools before we have taught our teachers and got our experimental stations going. Education will filter downwards rather than upwards. There may be considerable unwillingness on the part of elementary teachers to undergo training such as will be necessary. Professor Carmody's scheme of teaching them in the laboratory and experimental stations would prove expensive. I agree with him that it is impossible to teach agricultural science in these schools until we start our stations and train our teachers there. When that is done, teaching agriculture in elementary schools will most assuredly follow, though not, perhaps, on the lines we anticipate, for we are now dealing with paper schemes. Teachers will come from the stations qualified to teach elementary subjects and will probably make agricultural science the primary thing in elementary schools, which I believe it ought to be in these Colonies. We have been giving a great deal too much book work, and while the whole Conference deplores the lack of a proper text-book, I throw text-books to the wind. You do not teach swimming by text-books: it must be practically done. That is why I said you must start your experimental stations and then we will get on. We are apt to overlook the proper definition of "Agriculture". We may have education; we may train the brain, but we must also have the practical application of the training of the brain. This, I take it, is the object of the Imperial Department to teach the art and science of Agriculture. Art is practical; science is technical: we want the combination of the two.

Rev. W. SIMMS: One or two things occurred to me in the course of this debate. Of course several points mentioned as having been overlooked by me were not overlooked but omitted for want of time. As to training teachers, we must do it gradually. I am sure you will have better results at the end of ten years if you are content to instruct some of your teachers and not try to introduce agricultural teaching into all your

schools at once. Train all your future teachers. Every teacher that leaves the training colleges in 1899 should be trained in the subject. Train as many as you can of the existing teachers in the different Colonies. I am not acquainted with the systems in other Colonies, but in Jamaica almost all teachers are well up in the mediaeval system, in tickling the ground with their hoes. That is the extent of their agricultural knowledge; yet if you can get your teachers interested in the matter, there will not be a general unwillingness on the part of the children to take up the subject. That has been our difficulty, but it has been gradually overcome; the parents are being talked over, and the children are going to school. The matter of expenditure is a great obstacle. In Jamaica we are really in despair. We cannot even make a start. The mere tools for 150,000 school-children, of whom 70,000 are in average attendance, will be a serious item. We have not got the money. The President spoke of Blackie's Tropical Reader Book 1, but there is also a Book 2, and we intend having an agricultural text-book prepared. We have already drawn up the syllabus, but we have been in troublous waters for the last eighteen months in various ways financially, and the text-book got no further. With regard to certificates of efficiency mentioned by Dr. Nicholls, if something of the sort is done by the Imperial Department, it would be most important. Of course our teachers in Jamaica get ordinary certificates of efficiency from the Government, and where they teach agriculture they receive an increase of pay: but, if we look to the practical results, a certain gentleman here advises us to throw text-books away. It is, however, dangerous advice: ships do not travel merely by means of their anchors, but they need an anchor. The Irish Commission, while examining into the question, had a great variety of witnesses: every one agreed that the text-books were poor, but the Commission did not say to throw them away. The payment of teachers is a difficulty that has not been considered. Nothing is easier than for our agricultural teachers in Jamaica to get passes in words. I have a case in mind. During an examination at a place which the President knows, a class gave a beautiful definition of a mount, but when asked if they had ever seen one, they replied they had not. Now there was surrounding that school a range of mountains 6000 feet high! That is one of the difficulties in paying for passes at examinations—paying for teaching of mere words without any practical application. Among the points brought before the Irish Commission was the difficulty in the case of the School Inspector. The average Inspector is not a past-master in agriculture, certainly not in Jamaica; and in some places people complained that the worse the teacher taught the more he got: whereas the teacher who had got beyond the text-book and was capable of imparting information from his own knowledge did not do so well at examinations. The Inspector, it was said, knew nothing about the subject but examined from the book; so that the man who taught from the book was, for high marks and good pay, all right, while the man who had thrown books away was all wrong. You will have to bring the Inspectors to your Agricultural Stations if the pay of teachers is to

depend on school inspection. School inspection is a very serious matter. In the smaller islands there are only two Inspectors, but in Jamaica we have a staff of eight and most of them really knowing nothing of agriculture.

THE PRESIDENT: That closes the discussion on the subject of teaching Agriculture in Elementary Schools. I would suggest that we pass now to the other division of the subject the teaching of Agricultural Science in the Colleges of the West Indies. We have here, as I said, the Principals of the leading Colleges. I will ask my friend Mr. Deighton, the Principal of Harrison College in this Island, to be good enough to open the subject.

MR. HORACE DEIGHTON (Barbados): Hitherto my attention has not been directed to the consideration of the teaching of Agricultural Science but to the teaching of science generally, so that as a matter of fact I stand here to-day in the position of a learner and not in that of a teacher. I am afraid I can add very little to the discussion that will take place to-day. In all educational matters connected with the higher schools, we look to the Universites of Oxford and Cambridge for guidance, and I think in this matter of agricultural training we should do the same, especially as at Cambridge they grant a diploma for proficiency in agricultural knowledge. With regard to what is to be done in schools, that is a point to which my attention has only very lately been directed. I have had some talk with Professor d'Albuquerque on the subject, and our present idea is to begin the teaching of science at the bottom of the school and to work upwards through the different forms till the point is reached, where, as is at present the case with Classics and Mathematics, it will be necessary for boys to diverge, and those intended for Agriculture will drop certain subjects and devote to Science the time thus liberated. It is probable that this is the proper time to introduce Agriculture as distinct from the general science previously taught. Professor d'Albuquerque has promised to draw up a syllabus showing what work it will be desirable for each form to go through. These are really the only ideas that have at present struck me; for, as I have said before, my attention has only very lately been drawn to the question, and I am really in the the position of a learner rather than a teacher.

MR. J. A. POTBURY: I can only echo the words of Mr. Deighton, being here as a learner not as a teacher. I agree with what he has said with regard to a possible system for carrying out the idea of higher agricultural teaching. It seems to me that one great disadvantage is that the careers open to boys in ordinary and secondary schools here are not sufficiently varied. Boys in the West Indies have not the chances which boys in England, Europe and America have in scientific careers. It is a very grave difficulty that after a young man has received an ordinary education he does not know what to do. If he has failed to win a university scholarship, the chances of further education for a profession are lost; the Government services may be closed against him and he is left without any real career suited for his training. Scientific agriculture might open a large field.

If we can promise a good career to the intelligent boy who studies scientific agriculture, a great deal, I think, will have been done. Professor Harrison, who has charge of scientific teaching in British Guiana, will, I am sure, give additional hints as to the details of the work to be done. Speaking as the head master of a college, I should welcome any scheme that would afford the boy of ordinary intelligence the chance of a good career.

THE PRESIDENT: The effort of the Imperial Department of Agriculture in this direction is a simple one. The Department may in certain cases provide the means to employ Lecturers and give grants for scholarships.

MR. BURSLEM: I have been sent here by the Government of Trinidad to advance the proposal of the Agricultural Committee and to make suggestions generally on the introduction of agricultural education in Trinidad. There is one thing I would like to mention, that is the cost. In Trinidad for the last thirty years, four scholarships have been offered every year to enable young men to go to England to finish their education. The provision is liberal. The winners can go to the Universities, the Inns of Court, or to an Engineering Institute or become solicitors; or they can proceed to an Agricultural College in England or in any foreign country. During the thirty years that these scholarships have been in existence, not one boy has availed himself of the privilege of joining an Agricultural College, and I think the reason is that, when the course is finished, there is no possible opening for such a young man in Trinidad. Only the other day I was told of a student from St. Mary's College. His father, though not wealthy, had great regard for agricultural education, and sent his son to an Agricultural College at Edinburgh. The young man on his return could find no employment in his profession at Trinidad, and after idling for about three years, the Government, to give him some occupation, made him a road surveyor. There is no possible employment for such young men on estates: but the Government hope that something will come of this Conference and that agriculture will be introduced into the higher schools of Trinidad.

THE REV. W. CAROLI: We are all agreed, I think, that agricultural instruction, whether in first or second grade schools, must be based on properly trained teachers. With regard to introducing it into secondary schools, I have come here, like most of the other gentlemen, in search of light. But I do not think the colleges are prepared to introduce any elaborate scheme for agricultural instruction into their present system. I would also refer to the remarks of Professor Carmody about the Report of the Agricultural Society in dealing with scholarships. Agricultural Scholarships are best given by Agricultural Colleges to boys possessing an aptitude for the subject. If you give a scholarship to a young man who has finished his ordinary course of studies and force him to study agriculture, you may possibly force him into a position for which he has no natural ability and which may injure him. As Mr. Burslem has stated, the best young men would not study agriculture till

they saw a fair prospect of a livelihood in it. I know the individual, mentioned by Mr. Burslem, who passed out of an Agricultural College in Europe to find that he could obtain no employment in Trinidad. I am acquainted with some twenty very promising young natives of Trinidad. If they became trained agriculturists, Trinidad would be puzzled to find work for them, Giving agricultural education on a large scale would be risky. There may be gentlemen here who could suggest means for teaching agriculture to boys in these Colonies. I feel that an agricultural education that might ultimately assist in inducing capitalists to come and invest in these rich agricultural Colonies, would be of great advantage.

MR. DEIGHTON: As Head Master of Harrison College, I should be delighted to welcome the assistance of the teacher of agricultural science proposed to be supplied by the Imperial Department. Of course till I hear the amount of time that teacher could afford and the subjects he could undertake, I cannot suggest any detailed scheme.

THE TEACHING OF AGRICULTURAL SCIENCE AT COLLEGES.

By Professor D'ALBUQUERQUE., M.A., F.I.C., F.C.S.,

Some six years ago I drew up a Scheme for teaching Agricultural Science, which was accepted by the Education Board of Barbados. In view of Mr. Simms' excellent paper, it may be of interest to the Conference to give a short account of what that Scheme was, its working and results.

The Scheme provided for a "Science Department", the Regulations of which are appended, to consist of a head Institution at the Government Laboratory and two subsidiary centres at the Lodge School and Coleridge School. At each of these three centres, the subjects taught are elementary Chemistry and Botany.

At the Government Laboratory (attached to Harrison College) is given, in addition to the elementary teaching, a course of Instruction in Agricultural Science, comprising-

- Physics (Mechanics, Hydrostatics and Heat).
- Elementary Chemistry (Theoretical and Practical).
- Botany (including especially economic Plants).
- Principles of Agriculture (with special reference to tropical Plants).
- Sugar Planting and Manufacture including practical Sugar Chemistry.

The main object of the course, which was arranged to

occupy two years, is to teach the principles of Agricultural Science to boys who intend to become planters; but as a matter of fact the classes in the first three subjects have been largely attended as a preliminary course by boys intending to study Medicine, Engineering &c., elsewhere.

According to the rules of the Department, any member of a first or second grade school has the right to enter the course, provided he is at least 15 years of age and passes an examination in general subjects equal to the standard of the fourth form at Harrison College.

The teaching staff has hitherto been limited to the Assistant Professor of Chemistry and myself: and, partly owing to the smallness of the staff, but chiefly to the small amount of time which boys engaged in other school studies have been able to spare to the subject, no arrangements have been made for any actual field demonstration. It has, moreover, been found necessary not to exact the full age of 15 years, or the full standard of the fourth form: and boys under 15 and in the lower fourth have attended parts of the course. The rules provide for a periodical examination by the Cambridge Syndicate, which is held once a year, and for the awarding of certificates of proficiency in Agricultural Science. Considering the small numbers in the class, the short time most boys remain at it, and the low age of the boys, the reports have not been unsatisfactory: and one pupil, who took the full course and obtained the Department Certificate of Proficiency in Agricultural Science, has recently been appointed to a post under the Imperial Department of Agriculture.

Our success has hitherto been much handicapped by the following facts: First the comparatively low age and, consequently, insufficient previous education of most of the boys who attend, which render it impossible, in the number of hours per week allowed by Harrison College, to complete the full course under three years. Secondly, the boys generally stay at school only from nine to eighteen months after entering the Department classes: and having, as a rule, studied little or no science beforehand, they are at a disadvantage in the Cambridge Examination, when they are brought into comparison with boys in other subjects who (in the 4th, 5th and 6th forms) have been trained up to the Examination by several years' instruction. And thirdly, planting as a profession is now, as far as I can judge, rarely taken up by young men from choice, and while at school they, in most cases, keep that out of sight as a possible means of livelihood. It is my custom at the beginning of each term to enquire from every boy then entering the course what calling he hopes to persue in life. The replies are generally "Doctor," "Dentist," "Engineer," "Electrical Engineer," "Business," "Public Service," and only very rarely "Planter." No doubt the great depression in the sugar industry coupled with the long and dreary prospect of years as an overseer (locally called bookkeeper) with inadequate pay, have had much to do with this state of things. If the agricultural attorneys could see their way to increase the salaries and general comfort of the bookkeeper and would give the preference in,

selecting employés to those who hold certificates from the Department; and if parents could be induced to cause their sons while they are still at school to look forward to planting as a profession and devote some of the last two or three years of their school life to the study of Agricultural Science I am sure there would be a rapid increase in the knowledge of Scientific Agriculture amongst the rising generation.

The following notes with regard to the present system of Agricultural Science teaching in Barbados, are founded upon the assumption that an additional lecturer will be added to the staff from the Imperial Department grant, as the extension would be impossible without such material aid. It applies, of course, only to Barbados: and in the face of the improbability in the near future of the existence of any Agricultural College with a large staff, it aims at making immediate use of the existing agencies, with the aid of which I am of opinion that very useful and solid work can be done. The course would be primarily adapted to those intending to be sugar planters, but should be made adequate to the requirements of cultivators of other economic plants in such islands as Grenada, St. Vincent &c., where no institution for scientific instruction exists. In my opinion, the need in Barbados is not so much practical instruction in sugar planting, which is afforded to every bookkeeper on any well-managed estate, but it is such a grounding in those portions of Natural Science applying to Agriculture as will enable every young man who is destined to take part in the direction of sugar estates, to perceive the connection between the principles of Science and practical Agriculture and enable him to apply them to practice. I, therefore, think that while the conditions existing in other islands where the forms of cultivation are numerous will require a considerable amount of instruction in the practical operations of different types of Agriculture and Horticulture to be given a prominent place in the system so far as education in Barbados is intended for the sugar planter pure and simple, the Lecture Room and the Laboratory will, at any rate for two years, have to monopolize a great part (but not all) of the time. I am also of opinion that opportunities should be given to young planters already engaged on the estates, to attend, out of the crop time, lectures upon the principles of Agriculture and sugar planting and manufacture.

(1.) Elementary teaching should include the rudiments of Physics and courses in Chemistry at Harrison College, the Lodge and Coleridge Schools, as three elementary centres. The Government Laboratory is situated at Harrison College, and the College authorities have supplied good lecture and practical rooms which are well fitted up and supplied with apparatus. It follows that the school teaching there can be more extensive and thorough than that at the country centres. And I have recently approached the Head Master with a view to extending the school teaching, so that Physics and Chemistry can be taught in all the forms of the schools up to the fifth, like the other school subjects, and so that when a boy reaches the fifth form, where he usually selects his special study (*e.g.* classics or mathematics), he can, under the advice of the Head Master

and myself, also elect to take Agricultural Science almost exclusively and will then start on a satisfactory foundation of previous knowledge, and not be entering upon a perfectly new field. The present Science teaching in the general school is of a limited character.

(2.) Agricultural Science course. Before entering the Agricultural Science Class, a boy should, in most cases, be at least 15 years of age, and have studied the first four books of Euclid, and Algebra up to Simultaneous Equations. While studying the course or before, he should be instructed in very elementary Trigonometry and in Mechanics and Hydrostatics. Mensuration and Geometrical drawing would also be useful if not indispensable subjects of study: and all the above, together with one modern language at least, should be taken by the members of the school staff, and thus enable the Agricultural Science staff to devote themselves exclusively to their own special subjects.

The field instruction in Agriculture and sugar planting might, perhaps, be taken by Mr. Bovell, the Agricultural Superintendent of Sugar-Cane Experiments at estates near the school in the early morning when it is cool. The instruction in practical Horticulture could be undertaken by one of the Instructors of the local Agricultural Department: and, perhaps, one or two acres might be rented from Weymouth (adjoining Harrison College) for such cultivations. The lectures on Sugar planting and manufacture, Agriculture, etc., would be given at the Government Laboratory in the practical room, in which the Laboratory courses would be taken, and the manufacture would be exemplified by visits to the best boiling-houses during crop time.

The compilation of suitable text-books in each subject of the course suitable to local conditions would be valuable work within the scope of the officers of the Department, and should, of course, be based upon a carefully-considered syllabus.

I understand from Dr. Morris that the Imperial Department intends to offer Agricultural Scholarships to be held at Harrison College and elsewhere. They should be of sufficient value to pay fees and, in a few cases, include part of the expenses of board, and boys from the neighbouring small islands might participate. I suggest that these scholarships should be supplemented by others offered by the Education Board, and that some of those now given by local vestries should be specially attached to the Agricultural Science courses.

It has well been said (I think by the present Attorney General) that the Barbados Scholarship benefits the island rather by the unsuccessful competitors that remain behind, than by the successful ones who go away often not to return. This will apply to Agricultural Science, as soon as the Barbados Scholarship is thrown open to candidates in that subject.

SUBJECT SCHEME FOR THE AGRICULTURAL SCIENCE COURSE AT THE GOVERNMENT LABORATORY, HARRISON COLLEGE.

Subjects	Taught by
Modern Languages Mathematics Geometrical Drawing Mensuration Mechanics and Hydrostatics	By Harrison College Staff
Heat, Light and Meteorology Agricultural Chemistry Practical Chemistry Economic Botany Economic Entomology Elementary Physiology	By Science Department, including Lecturer paid by Imperial Grant
Agriculture and Horticulture Practical Agriculture and Horticulture Sugar Planting and Manufacture Practical Sugar Planting and Manufacture	By Science Department, including Lecturer paid by Imperial Grant and local Agricultural Officers.
Veterinary Surgery, Elements of	By Local Veterinary Surgeon.

The scientific teaching in the School Classes at Harrison College would be in addition to and precede, the above course.

THE REGULATIONS OF THE SCIENCE DEPARTMENT AS NOW EXISTING IN BARBADOS.

1. The Science Department of this Island shall consist of a central Institution at the Government Laboratory, and two Country Centres, one at the Lodge School, and the other at such place as the Education Board may hereafter determine.

Its Control.

2. Subject to these Rules laid down by the Education Board, the aforesaid Department, as well as the Assistants to the Island Professor, shall be under the direction and control of the Island Professor of Chemisty and Agricultural Science.

Its Object and Course of Instruction.

3. The object of the Department shall be to give instruction in Science, and particulary Agricultural Science, to pupils of the 1st and 2nd Grade Educational Establishments of the Island, and to provide for the formation of a Science

College, and to that end, at each of the aforesaid centres, shall be given courses of instruction in Natural Science.

Advanced Course at the Government Laboratory.

4. At the Government Laboratory there shall be an advanced course of instruction lasting two years and comprising (a) Natural Science; (b) Mathematics (including Geometry, Algebra, Trigonometry, Mechanics and Hydrostatics); (c) Modern Languages (French, compulsory; German, optional).*

Conditions of Entrance to Advanced Course.

5. Any boy desiring to enter the Advanced Scientific Course at the Government Laboratory must be (a) a pupil at one of the 1st or 2nd Grade Schools of this Island, (b) at least 15 years of age, and (c) must pass an examination in Elementary Classics, Mathematics, English and Modern Language. Pupils from any of the 1st or 2nd Grade Educational Establishments of the Island other than Harrison College† shall be admissible to section (a) only of this course, provided that

Conditions to pupils of other Schools.

1. They be and continue pupils of some 1st or 2nd Grade School in this Island.

2. They be of the age of 15 or upwards, and pass the aforesaid examination.

3. There be some proper guarantee that sections (b) and (c) of the course shall be adequately taught at the school at which they propose to continue.

4. So long as the Government Laboratory is within the precincts of Harrison College, they must be entirely under the discipline of Harrison College.

The Assistant to the Professor.

6. The Assistant to the Island Professor of Chemistry shall hold his post during the pleasure of the Education Board, and his duties shall be to assist the Island Professor and, if required by any educational establishment forming part of one of the two Country Centres, to give instruction during one day per week at that centre.

Discipline of the Centres.

7. Pupils of other schools, whilst attending classes at the respective centres, must be entirely under the discipline of the respective school which they are attending.

* It should be stated that the subjects under (a), (b) and (c) are to be taught by the College or School to which the pupil is attached and not by the officers of the Science Department.

† The First Grade Schools referred to are Harrison College and the Lodge School. The 2nd Grade Schools are Combermere, Parry and Coleridge Schools.

Examination and Diplomas.

8. An annual examination of advanced pupils shall be held by examiners to be appointed by the Education Board, and to those candidates who acquit themselves to the satisfaction of the examiners shall be awarded a certificate of Proficiency in Agricultural Science, which Certificate shall be signed by the Head Master of the Educational Establishment from which the boy proceeds, the Island Professor of Chemistry and the Chairman of the Board of Education.

DISCUSSION.

Professor HARRISON: I have been rather surprised to find people fancying there has been no attempt out here to teach agricultural science, or, better, the science of agriculture. I have been engaged in teaching the Science of Agriculture for twenty years. In 1888 when at Harrison College, I drafted a scheme by which we should have possessed an Agricultural College for the West Indies. I suggested after consultation with the Principal of Codrington College and Sir Charles Lees, then Governor of Barbados, that Codrington College might be used for teaching agriculture. The scheme was worked out thoroughly, the College visited and the land selected; but the Society for the Propagation of the Gospel refused to allow the College to be used for teaching the Science of Agriculture, on the ground, I believe, that the institution would be degraded.

The Rev. Canon BINDLEY: I am not quite sure whether Professor Harrison has accurately represented what was actually said by the Society for the Propagation of the Gospel. In 1888 the College seemed moribund, and the Government of Barbados proffered financial aid of a liberal nature and offered to make a certain allowance for some one who would teach the science of practical agriculture. The Society was somewhat obstinate as they were advised that, if they accepted financial aid, they would practically sacrifice part of their trust because the Colony would demand some control. The College is again *in articulo mortis*, but possibly the Society would not now raise the same objections. I think if the head of the Imperial Department (for the sake of the college buildings, the pleasantly situated grounds, and the plantations with their various elevations and soils) deemed it advisable to approach the Society for the use of the property as an experimental station and Agricultural College—his offer would be received with courtesy if not with welcome.

Professor P. CARMODY: From nine years' experience of teaching Agricultural Science at Trinidad, I am sure that the

scheme proposed at Trinidad, is as efficient a plan as we would care to adopt. I agree with Professor d'Albuquerque's suggestion for an extension of the present plan of agricultural teaching in this Island, to see if there is any demand for an Agricultural College. At present everybody talks of doing everything on a commercial basis: but to establish our College on a commercial basis would be to make a profit, and I am sure we should not adopt that plan. For an Agricultural College there would be a large staff of efficient professors, while, as has been stated, our students, when finished, would not find employment. It is a remarkable feature in technical education at home the facility with which individual students can of late obtain training in any special branch that they may require. A somewhat similar plan obtains at Trinidad on a small scale. As Government Analyst and Professor of Chemistry, I have made arrangements with the Government by which persons who have come to me for instruction in the analysis of manures, soils or sugar, can be admitted to the Laboratory at a nominal fee These are not always men seeking employment. but I should not get many students who wanted but had no prospect of, employment. The young planters are the people we want to teach first. I do not mean those actually engaged, but those who are to take their father's place. We should teach them only the principles of agriculture and let them get the practical work on the estate Scholarships may encourage persons who have not a taste for agriculture and that is not what we want to do. Great interest has been shown in my work in this direction by an attorney at Trinidad who insists on persons to be employed by him first passing through my Laboratory. If other planters made a similar condition for young candidates for employment, there would be little difficulty in deciding whether an Agricultural College should be established. Next there is the working class. If they take to agriculture they fancy they will make first class agriculturists with their practical experience alone and without any scientific knowledge of agriculture.

Mr. J. H. Hart: I agree with the lines for scientific education laid down by the previous speakers. One point appears to have been overlooked- the amount of practical education to be given on the estate. I am satisfied that the cadetships started by our President in Jamaica were a success. The botanic stations could afford a varied education of the greatest benefit to the planting community. I do not deprecate the teaching of scientific agriculture in schools and colleges in these Colonies. but I think the schoolboy. who is to get bread by the sweat of his brow, should fit himself on plantations for that work which is suited to his walk in life. Were scientific agriculture within the reach of every one, many planters would not be above taking advantage of the privilege. I have had applications from planters desirous of instruction at the new Experimental Station at Trinidad. That station has been much improved, and one of the most prominent men at Trinidad and one who devotes much time to educational matters Mr. de Verteuil — has spoken in high terms of the work being done there. That gentleman approves my proposal to have cadets at the station.

That plan would afford training subsidiary to the scholastic course at college and should, I think, be taken into account in any practical scheme considered by the Imperial Department of Agriculture.

THE REV. W. SIMMS: My scheme, which I think has been somewhat misunderstood, is a very modest one, much more so than Professor d'Albuquerque's. With regard to higher agricultural science the teacher proposed to be provided by the Department of Agriculture together with the present officials of the colleges should be able to afford a fairly good amount of teaching. I specially said that anything in the nature of an independent college would be impossible, even harmful. The want of a career is at the bottom of the whole thing. The salaries paid overseers and bookkeepers are too small to be accepted by any one who had received anything of a liberal education. The result is, when a planter wants to introduce something new, he has to send abroad for a competent man. That is our experience in Jamaica, and we are striving now by means of part of the scheme to provide scientific agriculture for higher grade boys: we want to train boys who are themselves going to be owners of plantations, large or small. Scholarships without examinations would not be wise: they might lead to favouritism or ineptitude. As to the sort of examination, I take the view of many technical and professional witnesses before the great Educational Commission in 1867, that you can only give scholarships to people who are to be trained in technical schools on their skilfulness, and that can best be decided by scholastic examinations. Agricultural scholarships must be on the same lines as other scholarships. Boys who desire scholarship will enter for the agricultural scholarships and the best boys will get them. They will be trained on the lines I have indicated mainly in agriculture, but to some extent in other subjects for part of the terms. At first I propose granting scholarships for one or two years, the agricultural training to be given at a central island station. I think we see our way to have such a station at Jamaica, and, *mutatis mutandis*, the same might doubtless be done elsewhere. The elementary school teacher must also work at that station. A good training at such a station will fit the boy for a planter, bookkeeper or overseer: while boys requiring wider knowledge must go to other countries.

THE PRESIDENT: That practically closes the discussion on teaching Agricultural Science in the Elementary Schools and Colleges. The papers just read made no mention of "Agricultural Schools" attached to the Botanic Stations. That is quite a distinct subject. Mr. Fawcett, who will now review it, has been Director of Public Gardens and Plantations for nearly thirteen years, and he has an Agricultural School attached to the Botanical Gardens at the Hope. Mr. Fawcett is also well acquainted with the system adopted in Jamaica for carrying on the work of "Travelling Agricultural Instructors." He will now read short papers on each of these subjects.

AGRICULTURAL INSTRUCTION

In Agricultural Schools in Jamaica.

By WILLIAM FAWCETT, B. Sc., F. L. S.

If I treat the subject somewhat historically, it may bring out more clearly what mistakes we have made and afford material for building up on a sure foundation.

For a long period a Reformatory and Industrial School has been in operation in Jamaica, where the boys received instruction not only in the ordinary curriculum of an elementary school, but also according to their capacities in the cultivation of the ground, in carpentry, cabinet-making, painting, tailoring, upholstering, bricklaying, masonry and blacksmith work.

In the year 1891, it was determined by the Government, to establish an Agricultural School for boys (who are not criminals) on land adjoining Hope Gardens, where the boys might not only have practice in general agricultural operations, but might also have the opportunity of receiving some instruction in the principles underlying those operations.

At first it was not placed under the Gardens Department, and no instructor was provided. A few boys were sent into the Garden for three hours' work in the morning, and another set in the afternoon. They were given certain work to do, but work done in this way without any personal anxiety on their own part about the results, and without any interest created in the why and wherefore, amounts to nothing more than mere drudgery. Now let us consider another scene. A peasant proprietor in the Blue Mountains who has been trained on a coffee plantation, teaches his children to weed his own patch of ground, pick the ripe coffee, pulp the berries, cure the beans, prune the trees, apply manure, place a cut banana stem across the slope to intercept washed soil, and to do all these various things at the proper season, watching rain and sunshine, with the intelligence, looking before and after, bred of the real personal interest taken in the fact that they are thereby earning their daily bread and storing up something to spend after many years of toil in the purchase, perhaps, of 3 or 4 more acres, or else in the luxury of the more immediate future a pair of boots or a new dress. If such a man can at the same time send his children three or four days a week to school to learn to read and write and work out correctly the elementary rules of arithmetic, he is giving them a first rate education for their sphere of life. In the "3 R's" he provides them with tools by which they are enabled the better to secure the wealth acquired by the toil of their hands, and to advance, if they are capable of it, to a higher level. But the real education, the training of the powers of observation, of experiment, of reasoning from cause to effect, and the skilful working of the hand and the eye in conjunction with the mind, — the education that makes the intelligent man, is given by the daily labour on his father's ground under his father's eye.

This is the kind of education to be aimed at in an agricultural school, and without a capable instructor who will take the place of such a father, there will be no real education.

The Hope agricultural school began with a schoolmaster, but without any one to give an explanation of the value of the manual labour, or to point out the laws of plant growth.

After a time I was enabled to secure the services of some one to teach the boys how to cultivate and cure cacao, but this arrangement lasted only a short time, and matters reverted to the state of only using the boys as labourers. This condition of things was to me most unsatisfactory. Buildings had been erected, salaries paid to a schoolmaster, warders, etc., and the boys were apparently expected to pick up a knowledge of gardening by simply working in the garden. It was not even as good or useful as the system of the Reformatory, where, although a master-carpenter at good wages was employed to teach carpentry, and so with tailoring and the other trades, any one was thought good enough to teach agriculture.

People laboured under the strange misconception that if a boy were only kept at work in a garden for two or three years, he ought at the end of that time to be a very fair gardener.

As there appeared to be a good deal of misunderstanding as to the nature of the training necessary to turn out a gardener, I attempted in one of my annual Reports to make the subject clearer, and to show the necessity for a well-trained instructor if a serious attempt was to be made to teach agriculture.

I then wrote—"In England where gardening is a regular business, perhaps not more than one in every 1000 of the population chooses it as a livelihood, and of those who are attracted to it not more than 50 per cent. are even moderately successful. It requires an aptitude and a love for gardening that few possess, in order to do well.

"The training is severe,—to give an instance, supplied by one who has undergone it—a boy is apprenticed for, from three to five years, and has to work like a slave 12 hours a day, and extra time in winter, making up hothouse fires. In the best gardens a premium of £10 or £20 is paid to the head gardeners. During the first year the boy gets no pay at all, and during the two next years about 3s. 6d. a week. He then goes as a journeyman gardener for five years or more, working 13 hours a day. He may then get a place as a foreman for from four to eight years, but he cannot do so unless he has already found spare time to read a good deal about the theory of the subject. After having served as foreman, he may, if he has been successful and is well recommended, get a post as head gardener.

"Of course, the object of the agricultural school is a more humble one, viz., to turn out the boys at the end of their time not only as good labourers, but with some idea of the reasons for various agricultural operations and some knowledge of proper methods of preparing produce for market.

"Even to become good labourers requires constant drilling in the elementary operations of digging, forking, raking,

hoeing, weeding, rolling, mowing, watering, etc., and all these require training by a man who understands the work. They cannot be taught by simply turning the boys into the garden and telling them to weed or dig.

"It is evident that—if the boys are to learn anything about pruning, budding, grafting and the particular cultivation necessary for various plants, and the methods for curing their products—they must receive instruction from those competent to impart it. In large gardens in England, they are passed on from one special gardener to another, learning one art from one, and another from another, but here there is no one in the gardens except the Superintendents themselves who could instruct them.

"The plan that commends itself most to my mind would be to appoint some one as instructor from one of the Agricultural Colleges either of England or America. It has been objected that such a person would know nothing of tropical agriculture, and therefore could not teach. But the principles of agriculture are the same in all climates, and the first essential is a sound foundation with capability of adaptation to differing circumstances. While the theory is the same, the practice is different, but a thorough knowledge of English agriculture combined with a scientific training appears to afford a better promise of success than any preparation at present available in tropical countries.

"Prof. Wallace in his work on *Indian Agriculture* recommends for similar work in India: 'Young farmers with a good general education, who have been trained from their youth in those details of agricultural practice which can only be acquired by early association with the farm and its purtenances, have within recent years been induced to undertake scientific study and research, in many instances with the object of becoming land agents, and in other cases so that they might be more able to contend with the increasing complications of the times, which have often proved too much for the old-fashioned farmers working according to old lights.'"

And, again, I pointed out that the office of such an Instructor is not only a most important, but also a most difficult one. There are many very different cultures, requiring special modes of treatment in the field and particular methods of curing and preparation for the market. The Instructor should not only be conversant with one or more of these cultures, but he should possess the rare faculty of being able to impart his knowledge to others.

If agricultural schools are situated in districts where some particular culture is by far the most important, the chief attention should be given to that,—sugar in one place, cacao in another, and so on.

The Instructor should be constantly with the boys during their work, pointing out from time to time, as occasion serves, any subject of interest, varying his questioning so as to make them reason out everything for themselves. Occasionally he would take them for a quarter of an hour in the schoolroom.

and demonstrate on the black board. He might also arrange experiments in flower-pots or in small plots of ground. He might again put all the plants, or even one, in a particular plot under the care of one boy, and those in another under another boy, and so on, making them work against one another to show the best results, and possibly the boys might have a personal interest in their crops, receiving part of their value when disposed of.

Although this plan of a special Instructor would give the best results, we have had to be content at Hope with something much more simple.

In October, 1893, arrangements were made by which the School was placed under the Department of Public Gardens. The Superintendent at Hope Gardens has the general supervision of the School, and also gives a demonstration for half an hour every day to the whole School in the Garden.

After the first six months, the Superintendent reported that the subjects dealt with had been as follows:—

Pruning young cacao trees

Pruning old cacao trees

Sowing Seeds of cacao

Potting seedlings of cacao

Pruning Liberian coffee

Forking, weeding, cleaning, watering and manuring land

Roots, stems and leaves: their work and the relation of one to another in the economy of the tree

Selection of fruit and seeds, in relation to progeny

Propagation by other means than by seed.

As an illustration of an experiment, the following may suffice:

Some trees of Liberian coffee were treated thus:—

No. 1 Lot. Trees were manured, forked, pruned and watered regularly.

No. 2 Lot. Trees were manured, forked, pruned, but not watered, merely receiving the ordinary rainfall.

No. 3 Lot. Trees were pruned, forked and watered, but not manured.

No. 4 Lot. Trees were simply pruned.

Such an experiment keenly interests the boys, and they watch the progress of the trees from month to month until the crop is gathered from each, and comparisons made between the value of the labour expended and the increased value of the crop, together with the good health of the tree, promising future crops.

In the same way experiments with various artificial ma-

nures may be made. the results being of permanent value to planters.

In the year 1895, the Superintendent reported that during the past year "the boys of the agricultural school have received instruction in the following practical work—pruning cacao: sowing seeds of cacao and coffee; potting seedlings; pruning coffee: planting ramie; planting pines and potatos (Irish), growing tomatos, carrots, turnips, cucumbers and ochras, weeding and cleaning land, manuring.

"In vine culture they have been instructed how to propagate vine plants from cuttings, how to make a proper border in which to grow the plants, how to plant out young and old vines, how to prune old vines, how to disbud old and young vines, how to stop old and young vines, how to train old and young vines.

"They have also been taught when to water and how to water vines, and, what is quite as important, when not to water.

"They have also had lessons in budding, an art in which they quickly got interested. After about six weeks' continuous patient instruction in the methods employed to remove the scion from its parent and to place it on the stock, they budded 90 orange plants out of which they got exactly half to grow—a very good result, considering how very awkward they were at first."

The school has continued on the same lines up to the present.

I have frequently called attention to the injury done to these boys by dismissing them when they reach the age of 16. A boy leaves the school with some little money, without any idea of how to manage for himself, and naturally falls amongst thieves, and spends his savings in riotous living. The Apprenticeship Law is found to be unworkable, but if barracks were erected in the Gardens, many or most of the lads would remain as labourers, and go on with their training, while the Superintendent would exercise a wholesome influence over them.

The Commissioners who were appointed to inquire into the system of education in Jamaica, have just issued their Report. They received satisfactory evidence of the value of the training in the school. One planter stated in evidence that his opinion was that one boy turned out of that institution is worth a dozen other boys in money value.

Another says:—"I went last month to the agricultural school at Hope and I was astonished to see the cleverness of the boys who were there under training. Their labour was of a class that we cannot get here at any price. The head men on our estates cannot do the work in pruning, budding and the like, that these boys were doing. The boys were town boys who were sent there through the Courts, but we want that education for our country boys, for they will come back and put that education into use." The Commissioners recommend that the school should be enlarged, and that "provision

should be made for resident or non-resident boys." This suggestion they consider very important, as in this way "the best scientific instruction in agriculture can be given to boys of all classes in the island."

The proposal to admit paying boys to the agricultural school is now occupying the attention of the Government, and if carried through, will prove a new departure.

The whole subject is a difficult one. I have put before you some of the points that have interested us in Jamaica, and hope that in the discussion I may have the benefit of advice that may help us.

PRACTICAL FIELD INSTRUCTION IN JAMAICA.

By William Fawcett, B. Sc., F. L. S.

In the early part of the year 1891, on the recommendation of Dr. Morris, a vote of £600 was passed by the Legislative Council of Jamaica for the purpose of providing Instructors to go amongst the peasantry, and show how improvements might be made in cultivating and in preparing products for the market. I may incidentally mention that a large proportion of the peasant class in Jamaica own small freeholds of their own, say of five to ten acres in extent. There are 81,924 holdings under ten acres each. In making plans for carrying out this proposal of the Government, it was felt that, in order to remove any suspicion that might arise about a Government Instructor, he should be directed to give assistance on large estates on his route, if the owners wished it. The Governor, Sir Henry Blake, laid it down as a principle that "the active co-operation of the people was absolutely necessary."

Communications were then opened with some of the most influential men in the various parishes throughout the island, asking their opinion whether an instructor would be useful in the districts near them.

The following are samples of the replies received:—(1) "I yesterday laid your letter before the members of the Parochial Board of this parish and they came to the conclusion that there really was no cultivation in the parish that the people did not understand. The members further thought that the people would decidedly object to their grounds being visited, as they believe that the intention of the Government is to increase

their taxes." (2) "After consulting with other gentlemen in the parish with reference to the subject of your letter, I do not know of any particular cultivation in this parish that could be improved by the means suggested,—not because the cultivation is carried on to the best advantage, but because of the insurmountable difficulty of inducing the cultivators to think so, or to bestir themselves to improve. There is a deeply-rooted conviction in the minds of the peasantry and others, that they know all that there is to be known with respect to the cultivation of the articles they produce, and I feel convinced that any attempt to get a meeting together for the purpose described in your letter would be futile."

The replies as a whole were so crushing that nothing more could then be attempted in that direction. However two years later, in September, 1893, I received the following letter :—

"With reference to the cacao industry, I have to inform you that I have made inquiry as to the willingness of the people for the aid of an Instructor and I have been assured by several of the well-to-do small proprietors that they will be glad to receive him and avail themselves of any instruction he may give. My brother, who has interested himself in fostering the industry among the settlers (he himself being a cultivator), will make all the necessary arrangements for the Instructor, such as the places where he should make experiments and lecture. I am assured that large numbers of persons will attend these lectures. The success of the Instructor will, I need hardly say, depend on his ability to adapt his language to the intelligence of the people, and the pains he takes to explain thoroughly what he teaches, added to these are a genial deportment towards the people, and an endeavour to persuade them that his object is to help them. This has been my experience in dealing with the people, and if I have succeeded in winning their confidence, it is in a great measure to be attributed to the carrying out of the foregoing suggestions. I may further add that the success of the movement in no way depends on the number of persons who attend the lectures. The idea is a new one and new-fangled things of this nature are never, at first, popular. Again, our people do not, all at one time, take up the cultivation of any product—they wait to see a few try, and if they succeed and it pays, everybody starts. It was so with the banana industry, and so with cacao. While several settlers have acres in cultivation, the many are only beginning now to plant. My firm belief is that, if two or three of the principal growers in each district adopt the suggestions of the Instructor, it will be enough they will educate the rest."

It was essential, if the scheme were to be carried out successfully, that the very best man that could be obtained should be sent. For, if he failed at the present opportunity, the whole scheme would be finally discredited; but if he should succeed in interesting the people, and in causing an improvement in cultivation and in the preparation of products, the scheme would be capable of great extension.

Mr. Cradwick, one of the Superintendents attached to th

Botanical Department, had already shown his ability in this direction at the Industrial School, and in dealing with the apprentices from Lagos who were working at the Hope Garden. He was accordingly sent. The success of the first venture was encouraging and gradually brought in applications from other places. Some extracts from the Instructor's Reports will show the method of procedure :

"On Wednesday I visited the Brandon Hill District. About 30 adults attended the demonstration, and as is usually the case, several of these evinced the keenest interest in the subjects dealt with, minutely observing the methods of pruning, curing etc., explained to them.

"Coffee, cacao, and canes are the chief products of the district. The two former are well adapted to the district, usually growing well, but as the people themselves realize now, they do not bear anything like the crops they might from the want of proper pruning."

"The subjects dealt with in the Stewart Town District were structure of plants and the uses of their several parts; the composition of soils, the uses of manures, particularly of stable and pigsty manure, and the value of vegetable matter in changing the physical character of the soil; the curing of produce and the enhancement of its value by the curing being well done; pruning of coffee and orange trees, the necessity of freeing them from parasitic growths, the desirability of shading coffee at low elevations, how to bud sweet oranges on to sour trees and the advantages of doing so.

"February 25th. Lectured in the Watt Town School-room to about 70 adults and about double that number of school children. The people here were keenly alive to the importance of the subject, and for an hour and a half after the lecture, kept up a string of sensible questions.

"February 26th. At 7 o'clock in the morning nearly 20 of the Watt Town people appeared at Cheri Magna to see the pruning of coffee, cacao, oranges and the budding of the latter; three hours were spent in the fields explaining the various operations.

"At 12 o'clock a meeting with lecture took place at Gibraltar, about 20 adults assembling and about the same number of school children. A great number of questions were again asked, and after the lecture the whole of the adults repaired to the fields, and a long time was spent in demonstrating as at Cheri Magna."

* * *

"March 3rd. Visited Lower Buxton and lectured to a gathering of about 40 people of whom two-thirds were landowners: dealt with kola, cacao, Liberian coffee, nutmegs, oranges, and rubber plants; the use of and the necessity for shade trees; the reasons for manuring, liming, digging and draining land; demonstrated on pruning of coffee and oranges, and the budding of the latter. This is a district where last year a planter complained of a large patch of coffee not bearing,

except round the outside. I pointed out to him that the trees were too thick and advised him to remove about half of them to a new field, and gave him practical instructions how to carry this out. He commenced the removal and then got frightened; but as the trees which he removed are now all growing nicely, he has recently removed a much larger quantity and the original patch has been much benefited by the accession of air and light caused by the removal of the trees.

"Coffee in this district, the people complained, dies out quickly, most frequently in patches. The cause, as I pointed out last year, is usually acidity or sourness of the soil; the remedy, digging up, liming and manuring. I fully explained this last year, and one small settler at once carried out my instruction on five or six trees: these trees, which last year were rapidly dying and were leafless, are recovering and putting out new growths, and the owner is now burning lime for the purpose of continuing the operation on other trees. The coffee growers around, seeing the great efficacy of the application of lime, etc., are doing likewise."

* * *

"March 16th. Demonstrated at 11 o'clock, about a dozen people being present including the proprietor, in the fields of Quebec, on the curing of coffee and cacao, the best kinds of cacao to grow and how to plant the same, also on budding oranges.

"Lectured in the Town Hall at Port Maria at 5 o'clock in the evening to about 70 persons on the products mentioned, demonstrating the process of budding and grafting by means of some branches of orange trees. The audience here had any number of questions to ask, most of which were purposeful and to the point."

* * *

"At Highgate I gave a demonstration in a very fine field of young cacao about six acres in extent. The cacao trees were of all ages up to two years, planted by sowing two and three seeds in one spot, in order that one tree might be secured in each place. Then in the usual fashion the whole were left to grow. Most of the trees required to be pruned also to prevent them from becoming non-bearing cacao trees. I explained the reason for pruning, and showed how to prune.

"At Belfield a fine young field of cacao was shown, which was simply going to bush for want of pruning. It was growing on good land, was kept clean and was old enough to bear; and yet it was not bearing, simply from the want of a knowledge of the proper treatment of the tree on the part of the owner.

"The district traversed is full of young cacao fields of all ages and sizes; but many of the people are becoming tired of the cultivation, as they say that the trees grow up all right, but bear little or nothing. It is of the greatest importance that the people should have it drummed into them that it is not the fault of the trees, locality, or soil, but simply that they,

allow the trees to grow gormandizers until they become forest trees with scarcely a pod on them."

These few extracts will afford a general indication of the style of instruction given. It varies in different districts according to soil, and plants cultivated.

It is important that the demonstrations be given periodically at regular intervals, in order that the instruction may be thoroughly drilled into the minds of the people; also that whatever may have been obscure in the directions already given may be made more clear by repetition and discussion; and that whatever mistakes may have been made during the interval may be pointed out.

I recommend, therefore, to send the Instructor once a year to the same district, if it is possible, and always supposing that the people desire it. Meantime fresh districts may be opened up.

It has been suggested that it would be an improvement on the present plan if a series of lectures running through the fundamental principles of agricultural science were given in definite centres at stated times. This might answer in countries more advanced in general education and knowledge of agricultural practice. In Jamaica, so far, our aim is, first of all, to reach those people who desire help, and then clearly to explain their individual difficulties, and to show how to correct their mistakes. The small proprietor wants to know why his few cacao trees are not bearing as well as the trees on the big estate close by: why his trees are always covered with moss, while his neighbour's are clear: why some trees have died from the roots up. The Instructor must go into the fields with the people, he must see their plants growing, and point out what is wrong, and how to improve. He must talk over with the people their difficulties, do some work on the spot on their own plants or their own soil, that they may watch from month to month what difference the draining of the land, or the pruning of the trees, makes in the crop. These demonstrations are supplemented by talks (or lectures, if the term be preferred) to larger audiences in school-rooms or chapels wherever there is a good centre. These general talks are also much appreciated; they last, perhaps, for an hour, and then for another hour or two the Instructor is engaged in answering questions put by the audience. These questions are generally very much to the point, and manifest a strong desire to learn and to improve.

The clergy and others in the various districts assist by making arrangements for the visits of the Instructor, and the success that has attended our efforts has been largely due to their great help and keen interest in the welfare of the people.

My experience of the peasant class in Jamaica is that, whenever they have been trained from childhood upwards on properties where careful and thorough work has been insisted

upon by the resident owner or manager, they have not only learnt to appreciate the value of such work, but they have followed out the good example on their own holdings; and, in fact, very often these small holdings bear marks of greater care and give better results than large properties, because they constantly receive attention from the eye of the owner to a greater extent than is possible over a large area.

I always, therefore, had faith in the ultimate success with the people of a plan of Field Instruction, if once a beginning were made in the right way.

The elements of uncertainty in obtaining favourable results depend, as we have seen, in a great measure on the amount of help from the local organizers, and on the attitude of the people themselves towards the scheme. But a much more important element of success is the choice of the instructors. A good instructor is born, not made. He must have great sympathy with the people, he must be capable of entering into their difficulties, of recognizing where those difficulties lie, even, perhaps, of expressing them. He must be patient with error, modest in the possession of more advanced knowledge. He must be thoroughly acquainted with and be an adept at the practice of the particular branch in which he is giving instruction. He should be capable of so giving his explanation, and stating the correct methods, that they will dawn on the minds of his audience as axiomatic truths, only requiring expression to be accepted.

I consider myself extremely fortunate in being able to utilize for this work such an admirable Instructor as Mr. Cradwick, who has shown in this special branch, as in others, the greatest zeal and energy.

I will close by saying that after 6 years' experience, I am more than satisfied with the results obtained; and I am convinced that, if our limited means of affording help in this way could only be extended, we could accomplish ten times the amount of good that is now being done.

DISCUSSION.

The PRESIDENT: You will agree with me that these papers show the practical side of the question of Agricultural Instruction started in Jamaica and carried on for some time with fair success. It is on somewhat similar lines that I propose to establish the Agricultural Schools at St. Vincent, Dominica and St. Kitts. These are to be attached to the

Botanical Stations under the charge of the Curators with suitable men under them to control the boys and teach them on the same lines as in Jamaica. The whole of the cost of maintaining these schools will be paid from Imperial funds.

Mr. H. POWELL: For the past five or six years I have, apart from being engaged as Curator, acted as a travelling instructor at St. Vincent, and the people have much appreciated my presence and work. Coffee, cacao and nutmegs are becoming established in the Island, and the crops are largely increasing, the people being, in spite of the hurricane, much more hopeful than formerly in consequence of the prospect of improved steamer communication.

The PRESIDENT thanked the Representatives from British Guiana for their attendance. They were unable to remain for the afternoon proceedings as their steamer was to leave early. Mr. Potbury suitably replied, and the Conference adjourned at 1 o'clock.

The Conference resumed at 2 o'clock.

The PRESIDENT: The first paper for this afternoon will be by Dr. Nicholls. He is well-known as the author of "Tropical Agriculture." This text-book obtained the premium offered by the Government of Jamaica and has since been published by Messrs. Macmillan & Co. Dr. Nicholls is himself a planter and has done valuable work in Dominica and other islands in the West Indies.

SUGGESTIONS FOR AGRICULTURAL DEVELOPMENT IN THE LEEWARD ISLANDS.

BY H. A. ALFORD NICHOLLS, C. M. G., M. D., F. L. S., C. M. Z. S.

Before proceeding to the subject of my paper, I would take this opportunity of expressing on behalf of many able and far-seeing residents in the Leeward Islands the satisfaction that is felt at the appointment of Dr. Morris to direct the Imperial Department of Agriculture for the West Indies. Dr. Morris is acknowledged throughout the world to be *facile princeps* in scientific and economic botany as applied to tropical agriculture: and, moreover, his special experience is as wide as his special knowledge, so that the selection of so distinguished an authority to act as the Imperial Commissioner of Agriculture is conclusive evidence that the Home Government intend to do what lies within their power to bring prosperity to these fruitful but unfortunate Colonies.

The calling together of this Conference shows that Dr.

Morris is desirous of carrying on his important work, not alone and irrespective of local knowledge and experience, but with the aid of those men who may justly be considered as authorities on questions relating to West Indian agriculture and education. The movement is wise in its conception, and it must be followed by most beneficial results. It will also weld together into one earnest working body the Imperial Department of Agriculture and the leading agricultural and educational authorities of the West Indies. I may, perhaps, be permitted to suggest that arrangement be made at future Conferences for the representation of planters by suitable delegates, who would, I am sure, take a worthy and useful part in the deliberations.

Dr. Morris asked me to prepare a short suggestive paper on the Leeward Islands, and so I propose to confine myself to a few remarks on what has struck me as matters that are worthy of consideration in any scheme for the improvement of the islands I represent here.

DOMINICA.

Dominica, the island of which I have necessarily most knowledge, is the least developed; and, if Jamaica and Trinidad be excluded, it is the largest of the British possessions in the Antilles. Owing to circumstances that would take too much time to detail here, it was one of the first of the West Indian islands to feel acutely the evil days that fell on the sugar industry.

But it has always appeared to me that there were some compensating advantages to Dominica in the collapse of the sugar industry, in as much as the people were forced to direct earnest attention to other cultivations for which the island is so well adapted. In expressing this opinion years ago, I brought down on myself much opprobrium, but now many persons are ready at once to agree in such a view when it is enunciated.

There is much land in the island eminently suited for cane cultivation, but with one exception all the fine sugar estates that once existed are now abandoned or cultivated with other products. This revolution in the industrial occupations of the people meant much suffering and distress amongst the inhabitants, and it is greatly to their credit that they have by now replaced the sugar cultivation as it existed in 1883 by other cultural industries. Last year the sugar products exported from the island were less in value than the year's production of essential oils, so that Dominica could get on very well if the sugar cane disappeared entirely from the island; but much has yet to be done before the colony can be said to be prosperous, and outside help is greatly needed.

Practically the coast districts are now alone cultivated and the best and richest lands are still covered with the primeval forest or have reverted to bush by reason of the collapse of the sugar industry. The Home Government proposes to open these interior tracts by roads, and should this be satisfactorily accomplished, an impetus will, no doubt, be given to the agricultural

development of the island, for a number of Englishmen have recently settled in the Colony, and inquiries for land are continually being made. At the present time, however, what is most wanted is a proper coastal steam service for the Windward or Eastern side of the island, where there are many settlers who can be reached only by long journeys over the steep bridle-paths which cross the central chain of mountains.

This difficulty of communication stands in the way of the cultivation of the land and depreciates the value of the products raised by reason of the greatly increased cost of transit to the port of shipment. The residents have recently addressed a memorial to the Secretary of State on this matter, and probably a favourable expression of opinion by this Conference would greatly assist in providing Dominica with a steam coastal service so necessary for its future welfare.

Owing to its mountainous nature, the island possesses a variety of soils and climates which renders it possible for a multiplicity of cultural industries to be established. There are really three zones: Firstly, the coast zone, or the lowlands, suitable for sugar cultivation, limes, cacao, Liberian coffee, cocoa-nuts, fibre and starch-bearing plants and Ceara rubber, etc. Secondly, the middle zone, extending from an elevation of 1,000ft. to 2,000ft. above the sea-level, and suitable for the cultivation of oranges and other fruits, cardamoms, vanilla, nutmegs, cloves, cinnamon, kola-nuts, cacao, Para rubber, etc. And, thirdly, the higher zone above an elevation of 2,000 ft., suitable for coffee and early temperate vegetables, as well as some of the temperate fruits, which might be shipped profitably to the centres of population in North America.

The higher lands are not now cultivated, with the exception of one isolated spot where a Ceylon planter within the last year has started a coffee plantation. What appears to me to be needed to assist in the profitable opening up of these lands for cultivation is the establishment of a hill botanic garden wherein may be seen plots of land properly planted with those economic plants found suitable to the soil and climate. This would be a most valuable object lesson to the people, and it would be of immense service to new settlers, who, it is hoped, will be attracted to the island in greater numbers.

In Dominica there is a very numerous body of peasant proprietors, and the greater portion of the large cacao shipments comes from their holdings. But, unhappily, they are greatly wanting in knowledge of the proper principles of agriculture, and of the best way to prepare their produce.

The result is that their lands do not give anything like the return they ought. The proposed agricultural training in the schools, and the appointment of travelling agricultural instructors will in time tend to remove this evil. The older men, I fear, are in a hopeless case, but the younger generation can be got at and taught to make the most advantage of their holdings. But there is another great drawback to the prosperity of the peasant proprietors in Dominica and elsewhere and that is the established system of parents leaving their lands to their children

as tenants in common, and this system goes on until a few acres of land are owned often by a large number of descendants of the original proprietors. What one plants the other reaps, and thus constant disputes and serious quarrels result: which often lead the disputants to the magistrates' courts and even to prison. This very serious evil helps to prevent the cultivation of the land and keeps the peasant proprietors in a state of poverty. A magistrate who has an extensive district on the Windward side of the island, recently spoke to me in very strong terms concerning the wide extent of this evil, and he stated that much of his time was taken up in adjudicating on disputes and assaults arising from this common ownership of the land. I take it that any matter concerning the agricultural prosperity of these islands is a fit subject for discussion, and, therefore, I bring forward this evil for the consideration of the Conference in orde:, if possible, that subsequent action may be taken for its abolition or mitigation.

ANTIGUA.

Antigua always has been and is now entirely dependent on sugar for its prosperity. There are no mining or manufacturing industries in the country: and, so far, various attempts to establish secondary cultivations have proved unsuccessful. The failure of these attempts are due, I believe, to the physical peculiarities of the island, as well as to its climate. The soil is rich, but the trade winds sweep over the land and periodic droughts or dry seasons occur. Most of the tropical cultivations require abundant rain and sheltered situations for their successful prosecution. These conditions are absent in Antigua, and the comparative failure of the first Botanic Station was due to its dry and wind-swept site.

Owing to the long continued depression of the sugar trade in these colonies, Antigua is in a deplorable condition. Much fine land that was formerly the scene of successful industry is now abandoned, and the sugar planters who are still holding out are, in many instances, in severe difficulties. The labouring population is necessarily in distress, and sad tales of poverty amongst all classes are heard in every direction. The outlook in these circumstances is gloomy in the extreme: for unless there be a turn in the tide, wide-spread ruin with all its concomitant difficulties may be looked for at no distant time. It is believed by many of the leading men that any assistance other than the bringing about of the revival of the sugar industry, will only stave off for a time the evil day of general disaster. It is foreign to the purpose of this paper to discuss the question as to what measures are necessary to bring prosperity to the sugar planters, but I may mention that there is a consensus of opinion that the only way to effect this desirable end is the abolition of foreign bounties or their neutralization in the home markets by the imposition of countervailing duties.

Any methods, however, that are calculated to increase the output of sugar from given areas and to decrease the cost of production, should be carried out where possible with no un-

necessary delay. Speaking generally, what strikes one on visiting the sugar estates in the Leeward Islands is the fact that each property, small in itself, has to support its own independent sugar factory.

I have remarked that Antigua is subject to droughts, and it is an important question whether the influence of these spells of excessively dry weather cannot be mitigated. I believe they can, to a certain extent, by a proper system of afforestation. The lowlands, as now, should be kept in future for cultivation, but the summits and a portion of the declivities of all the numerous hills should be covered with trees. It is still, I believe, a moot point whether or not forests attract rainfall; but it is an established fact that they increase the humidity of the climate and retain moisture in the soil. In my visits to Antigua, I have been much struck by the bare appearance of the hills, and it has always occurred to me that it would greatly benefit the island in several ways if steps were taken to cover the high lands again with the tree growth of which they have been denuded.

Although sugar must of necessity be the great staple product of Antigua, a number of small industries might be established to the great advantage of the people and the country. What plants can be cultivated in the island is doubtless one of the important matters that will engage the attention of the officers of the Botanic Station when it is reorganized and properly equipped. But I may mention that Ceara rubber, *Manihot Glaziovii*, would grow in the soil and climate of Antigua, and it might well be one of the trees planted on the hills if it be decided to afforest them.

Logwood, too, thrives in the island. I understand it was introduced many years ago by Dr. W. H. Edwards, and it has now firmly established itself in portions of the dry waste lands. A few years ago it was discovered in the island that it might be exported, and at once a trade sprang up which gave useful and opportune employment to many half-starving labourers. This product in process of time might be made an important and profitable one. The tree sows itself widely, and with a little intelligent care and expenditure a tract of land covered with logwood trees may be made to give a certain annual revenue and provide employment for many labourers.

ST. KITTS AND NEVIS.

The observations I have made regarding the sugar industry in Antigua apply with equal force to St. Kitts and Nevis.

In St. Kitts sugar is practically the only industry, and as the labouring population is mainly dependent on imported food products, the distress amongst the people has arrived at an acute stage. There is a central mass of mountains in the island, but the mountain lands are divided amongst the estates and they are, therefore, not available for settlement by the people. These high lands are not very extensive; but they are capable of supporting a considerable number of peasant proprietors who could raise food products and engage in other small

industries that would in the end, I believe, greatly benefit the country, the mass of the people, and even the planters themselves. In the present condition of the island, the mountain lands are not of much use to the estate owners, who would doubtless be ready to sell them to the Government if it were decided to take steps to establish a peasant proprietary in the island.

In Nevis, although poverty is almost universal owing to the difficulties into which the sugar industry has been plunged, many of the people are better off than their neighbours of St. Kitts, in as much as food products are raised in the islands, for there are numbers of peasant proprietors some of whom are in fairly comfortable circumstances. When I went through the Gingerland district, I was much struck with the intelligence of and the progress that had been made by, the cottagers. Nevis, indeed, is the market garden of St. Kitts, and, if agricultural instructors went amongst the people, much lasting good would doubtless be effected. The highlands of Nevis are not extensive, but the soil is good: and, to a limited extent, some of the minor industries might be established on them.

ANGUILLA.

The flat island of Anguilla is a dependency of the presidency of St. Kitts Nevis although it is 60 miles from St. Kitts. Its area is 35 square miles, that is rather more than a fifth of the extent of Barbados. The population is between three and four thousand. A very small proportion of the inhabitants are engaged in working the salt pond, and the rest of the people have a hard struggle for existence: for only ground provisions are cultivated, and the island is subject to severe droughts. The soil is good but dry, for there are practically no trees to retain the moisture in the ground by minimizing percolation and evaporation. One of the peculiarities that struck me on my visits to the island was the absence of trees and the shifts the people are put to in erecting their wretched huts for the want of cheap timber. Much general good would be effected if an organized system of tree planting were adopted, and Ceara rubber and other trees of economic value might be in part utilized for the purpose. There is also great need for the establishment of some cultivation that would provide a staple export. It has been demonstrated that the fibre plants thrive in the soil and climate, but the Government Sisal hemp plantation was unaccountably abandoned as soon as the plants were ready for reaping operations. In the year 1891, I suggested to the Leeward Islands Government that several families of peasants from Carriacou having a knowledge of cotton cultivation should be settled in Anguilla, and the Governor of the Windward Islands promised me to do what he could to carry out the plan. But the Governor of the Leeward Islands, Sir William Haynes Smith, was then busily engaged in larger schemes and my suggestions, although approved of, came to nothing. Perhaps under the new Imperial Department of Agriculture something may yet be done to help the impov-

erished population of Anguilla by providing them with industrial occupations.

MONTSERRAT.

In Montserrat the sugar industry is the main one of the island. It provides, in value, over 60 per cent. of the total exports of the colony, and, therefore, the accounts given of the condition of Antigua and St. Kitts-Nevis apply in a great measure to this island. In fact, it has been said by competent authorities that the sugar industry is in imminent danger of extinction. Happily for the country, however, the Montserrat Company, established by the Sturges of Birmingham, has successfully introduced lime, coffee, cacao and several other smaller cultivations that have saved the island from ruin, for the Company's example has been followed by other landowners. It is an interesting and instructive fact that the cacao and coffee shipped from Montserrat by the Company obtain a very high price in the home markets. Care was of course taken that none but the better kinds of seed were sown, and this has resulted in the reaping of an excellent product.

There are in Montserrat many peasant proprietors who might successfully raise cacao or other products. But most of them are engaged in cane cultivation, and the sugar crisis has thrown them into such poverty that they are unable to establish other industries. In regard to this matter, Mr. Edward Baynes, the Commissioner, in an able memorandum presented to the Royal Commissioners, made the following suggestive statements:—

"The substitution of other industries for sugar would, if "the necessary capital were forthcoming, be more feasible in "this than in many of the other islands, and the extension of "existing industries and establishment of others would eventually produce a condition of prosperity. Lime cultivation "can be largely extended, and cacao would grow on many of "the estates now cultivated in cane. Liberian coffee would "also probably be successful on some of these estates, and "the cultivation of Arabian coffee can be extended in the "mountain lands. But all these industries require time for "their development, and the proprietors, already impoverished "by the fall in sugar, are not in a position to procure capital "on which no return can be expected for several years. If, "therefore, nothing can be done for sugar, efforts should be "made in the direction of enabling the proprietors to procure "capital for developing the new industries, and tiding over "the interval before they can be brought to profitable account."

In my own memorandum on Dominica published in the report of the Royal Commissioners, the important question of the impossibility of landowners obtaining capital to assist them in working lands was alluded to in the following words:— "Although considerable progress has been made in replacing "the cultivation of the sugar cane by other industries, very "much more would have been accomplished but for the lack of

"capital in the island and the impossibility of obtaining it else-"where. Had there been a *crédit foncier*, or land bank, to "advance money on fairly easy terms to the proprietors, Domi-"nica might by now have been prosperous; for many of the "waste lands around the coasts would doubtless have been "covered with paying cultivation, and the rich lands of the "interior, which are at present unavailable on account of their "inaccessibility, might have been opened up for settlement. In "some instances money could be obtained from London mer-"chants as advances against crops, but in lime, cacao, coffee and "other cultivations, no crops can be expected until several "years have elapsed from the time of planting. The only bank "in the island does not lend money on mortgage, and the local "merchants are unable or unwilling to do so." . . . .

"Should means be adopted for obtaining capital at reason-"able interest to help the planters in extending the present "industries of the island, and in establishing others, there "would be, I believe, no hesitation on the part of the Legisla-"ture in adopting the necessary measure to guarantee the "money advanced."

In the present economic condition of these colonies, the question of capital is really one of supreme importance and it is one, I think, that should engage the attention of the Imperial Government. In all the islands there are large tracts of land suitable for various cultivations, and the landowners are not only willing, but they are anxious to prosecute any agricultural industry that gives a fair promise of profit, but this they cannot do as they are without capital and without present means of obtaining any. The Imperial Government propose to provide capital under certain conditions for proprietors in those islands devastated by the recent hurricane. The planters of the other islands, however, are suffering from what may be described as a commercial hurricane which has swept away their fortunes and left them and those dependent on them practically helpless in their distress. These people deserve help as much as they need it: for their reverses are not due to their own mismanagement or thriftlessness, but to the operation of fiscal causes beyond their control, by which, moreover, the people of Great Britain have largely profited.

VIRGIN ISLANDS.

The presidency of the Virgin Islands consists of an archipelago, the total area of which is about 58 square miles supporting a population of about 5,000. The two largest islands are Tortola and Virgin Gorda—the latter possessing some mineral wealth, a copper mine having been worked in it some years ago. The people are now engaged in fishing, raising cattle, and in the cultivation of ground provisions for the St. Thomas market. The soil of Tortola is fruitful, and some of the minor cultivations might be prosecuted to the advantage of the people and the presidency. But it would be hopeless to expect this until the people are instructed in the principles of agriculture, for there is no cultivated estate in the group of islands to serve as an object lesson to the inhabitants. And

this brings me to the question of agricultural instruction, on which I would make a few brief observations.

It has been seen that in the Colony of the Leeward Islands there are no manufactures and no existing mining industries, and that the islands are entirely dependent on agriculture for their fortunes. And yet, strange to say, agriculture is the one subject that has hitherto been entirely neglected in all the educational establishments of the Colony. A similar tale can be told as regards the other Colonies in the Antilles. In these days of keen competiton in all the industries of the world, those who are not properly equipped for the battle of industries cannot hope to prevail, any more than could an army of imperfectly trained soldiers be expected to be victorious in war. The establishment, therefore, of the Imperial Department of Agriculture for the West Indies is an important epoch in the history of the Colonies, for it marks, I hope and believe, the dawn of a new and happy era in lands that ought to be the homes of a contented and prosperous people.

DISCUSSION.

MR. FRANCIS WATTS: I was not aware that Dr. Nicholls would traverse the conditions existing in the Leeward Islands and that I would be called upon to offer some comment. It is true that I am acquainted with some of the economic conditions prevailing in that part of the West Indies. One of the things which struck me in listening to Dr. Nicholls is the change in the conditions there since my removal to Jamaica. One has to study carefully the individual character of each island or group of islands before he can make recommendations for the conditions he may find there. I have found myself transported from the Leeward Islands, which I knew fairly well, to other conditions at Jamaica, where, if I were to offer suggestions based purely on my experience of the Leeward Islands, they might lead to confusion and loss. It is, therefore, important to have such a paper as Dr. Nicholls's carefully reviewing the conditions of this group of islands. Dr. Nicholls most carefully separated the conditions of Dominica, where he resides, from the conditions of Antigua. Dominica has made a great change from sugar to other industries. In that respect Dominica is the Jamaica of the Lesser Antilles. Its conditions are much more like those of Jamaica than those of any other island I have seen. The conditions of Antigua and Montserrat are distinct from those of Dominica, and must be distinctly studied. Dr. Nicholls has referred to the well-known absence of forests in Antigua. This is due to the pernicious habit of setting fire to grass tracts in order to produce fresh grass for their cattle. There are laws in existence capable, I am told, of dealing with this dangerous and pernicious habit; but they have not in a single instance been put into effect. All efforts to cultivate trees as forests on the small hills are rendered futile by the reckless practice of lighting fires which can be seen day after day sweeping over

the land and keeping the country dry and unarable. Mr. Hooper was able to find out that in those districts where these grass fires were unknown. not only did trees thrive, but under them could be seen a dense growth of seedlings ready to take the place of the parent trees. This disastrous custom of setting fires must be stopped, because one of the things that will assist in the prosperity of the Colony is to cover the hills with trees. It is difficult to imagine how the sugar industry—i.e. the muscovado process—will live through and assist in raising Montserrat. But sugar is only one of the industries that must be taken up. The cultivation of cotton in Anguilla has been carried on till recently: but to work this on a large scale there, you must be able to command labour. I am surprised that, in all the discussions during many years on West Indian produce, so little has been said about oil crops. Dr. Nicholls mentioned the good quality of Montserrat cacao and the high prices obtained for it. That was due to the energies of the people connected with the Montserrat Company who carried into the island the knowledge of growing, and preparing the article for the market. It should also be noticed that the Curator of the Botanic Station at Montserrat recommended the varieties of cacao that should be grown. Perhaps no part of the West Indies will derive more benefit from the scheme of the Imperial Department of Agriculture with its directing energies, wise control and centralizing ideas than the Leeward Islands.

IMPROVEMENT IN AGRICULTURAL METHODS IN THE WEST INDIES.

By J. H. Hart, F.L.S.

The improvement of the different Agri-Horticultural products grown in the tropics must be taken by every one to be quite as desirable and as advantageous as are the improvements which have been continuously made in the quality of the various fruits, cereals, and roots of the temperate zone. The smallest improvement which is effected, must from the very nature of the case be beneficial, because it at once puts a more desirable commodity in front of the consumer, for which the grower obtains a higher and better price and sells well even at times when inferior material is unsaleable. This applies as well to export as to local trade, for it cannot be disputed that the superior article is always able to command the best price, and gradually ousts commoner products from the markets.

High-class produce will give returns which will, proportionately, benefit the Colony in which it is grown, but this benefit will of necessity be shared in time by neighbouring colonies; therefore, not only will a colony benefit itself by raising high-class produce, but it will also bring direct bene-

fit to its immediate neighbours. By high-class produce, I refer not only to those productions which bring the highest price, but also to those which "meet the demands of the market" to which they are sent, and those which obtain the most ready sale.

In the West Indies there is a great want of emulation and friendly competition, which in other countries do so much to stimulate the planter to seek for the most approved kinds of produce for cultivation; but I am of opinion that competition would arise if once the value of the material was prominently brought forward, and the colonies would then vie with one another in growing the best produce, in making the best market, and in distributing to its neighbours, for a consideration of course, seeds and plants of the best strains. We should then have a healthy competition which, I believe, would result in mutual gain. Once get the principle correctly understood, viz., that which benefits one, benefits all, and we should be far on the road to substantial improvement.

We frequently find instances which tend to delay attempts at improvement. Such, of course, are unavoidable and should be taken as warnings not to rush to a hasty conclusion. An instance may be mentioned. A planter was induced to plant a new cane which had been highly recommended. Despite all warnings he planted largely, and met with lamentable failure, as the cane was utterly unsuited to the land with which he had to deal. He has now condemned and rooted out all seedling canes, on account of this one failure, while the blame in reality rests upon his own shoulders for attempting to work with material that had been insufficiently tested.

While it cannot be denied that improvements have been made, and are still being made, in the quality of various products in temperate climes, on the other hand, it cannot be concealed that in the tropics there has been no continuous or well-organized attempt to improve the character of our tropical produce except in the case of sugar cane in Demerara and Barbados.

To point to the good that might accrue from well-planned effort, to direct attention to the end in view, and to discuss the means by which progress may be made, is the object of the present paper.

I take it to be admitted that improvement in the quality of West Indian produce would be desirable and beneficial and would add to the wealth and prosperity of the Islands; it is, therefore, necessary to discuss the means by which improvement can be effected.

To go through the whole list of the products of the West Indies which are capable of improvement, would take up too much time, and besides two or three will serve as illustrations of what is possible, for the means of improvement are similar in each case.

I place the sugar cane first on the list because at the present time it is probably more in need of assistance than any other

kind of cultivation. Some people, as I have said before, do not believe this, and hold to the idea that the Bourbon, the Transparent or the old Purple are quite good enough, if they could only get the Home Government to agree to "countervailing duties," or some other panacea for their troubles. I deny that they are good enough: they stand in need of improvement, and if proper improvement were effected, the position of the sugar industry would be in a very different state to what it is to-day.

Now, it is no use beating about the bush: it is better to say at once that, if sugar is ever again to prosper, it must be on different lines to those of the past. Some, perhaps, would reply to this, well if it must be done, why don't you start and do it? The answer to the question is ready. A start has already been made, and no little success has been achieved. However, work of this kind cannot be done in a day, for it is really the work of years, and work that "should" have been begun years ago. There is no little reproach in the use of the word "should," for if the work had been begun soon enough, we should not be so far from the ideal as we are to-day. Under proper direction we should have been able to have offered the planter other choice besides the Bourbon and the Transparent canes, but we have not arrived at this as yet. We are in possession of canes today, however, that may prove to be capable of surpassing the Bourbon for all the purposes of the planter, and further, that may be capable of being cultivated with greater economy. These canes, however, are not yet out of their trial stages, and though they promise well, it would be the height of folly to recommend them to the planter until they have been fully tested in all classes of climate and soils.

To enable any one to realize the possibility of producing better canes than the older kinds, we have only to turn to the excellent illustration which is afforded by the beet sugar industry (See *Kew Bulletin*, 1897, p. 317). We there find that in 1896, M. Vilmorin of Paris wrote to the Director of the Royal Gardens, Kew, a letter describing the progress of the improvement in the quality of the sugar beet, which, in short, ran as follows: When first known the sugar beet *(Beta maritima)* contained from 8 to 10 per cent. of its weight in sugar. Selection was then brought to bear and the sugar content was raised to 12 or 13 per cent., but this improvement took some fifty years. Then more accurate means of ascertaining the sugar value of individual roots were found, and "in a dozen years a race was established yielding 16 to 18 per cent. sugar, and this has raised beet-sugar making from a bad job to a prosperous industry." Now the method used by Vilmorin and others, to bring the beet to perfection as a sugar producer, is a process of seminal selection and chemical examination, *i.e.*, seedlings are grown and from these the best sugar producers are selected year after year, after being tested for sugar by the polariscope. Individual beet roots were grown from seed, and each individual root was first tested by having a portion of its substance taken away, without destroying the life of the root, when, if found to contain a certain per cent. of sugar, it was reserved and planted for seed, only those roots

being used that were found to be fine sugar producers.

In this way the result has been obtained that we see to-day that beet sugar is able to compete with cane sugar in the markets of the world. If the same progress had been made with the improvement of the cane as has taken place with the beet, we should to-day have in our fields canes giving over 20 per cent. of sugar, instead of some 12-14 per cent., and this extra percentage would have enabled the cane to have maintained its standing as against the beet. Sugar planters say that they could hold their own if they only obtained the imposition of "countervailing duties," but it appears to be a matter of great doubt whether the cane planter and manufacturer could ever successfully contend with the manufacturer of the temperate zone unless he had points of production in his favour, as production and manufacture are much more economically carried on in the temperate zone. Beet has, however, reached the highest point of production which is possible, for it is freely admitted that the beet root cannot be made to hold more sugar, while we have for our comfort the fact that "the cane can hold a far higher percentage of sugar than has yet been extracted:" and there is, therefore, every incentive for progression and improvement. One reason which once kept back progress in this direction was the belief that the cane did not produce fertile seeds. The history of the proof to the contrary is well known in the West Indies, and Barbados has the credit of making the first start in the direction of improvement. Work in the same direction has since been carried on both in Demerara and Trinidad, and from a comparison of results it is seen that there is every hope that canes will soon be on hand which will drive out of cultivation by fair competition the favourite old kinds so dear to the heart of the planter. There is also direct evidence that the time will not be long deferred, for in the report of the planters, to the Trinidad Agricultural Society, on the results of the 1898 crop from the new canes, the following occurred: Eleven varieties ground together "gave an average weight of 77 tons to the acre and the specific gravity of the juice was 1·078." As time goes on probably more definite and favourable reports will be forth-coming.

We have a distinct advantage in carrying on our efforts at improvement, for we start with all the previous experience of the beet-root raisers to guide us. As to the time it will take to reach the goal, though it must of necessity be long, yet it will in all probability not be nearly so long as it took for the improvement of the beet root, even in the last stages of the process.

It will have been observed in the various reports that the method of procedure with the cane, is the exact counterpart of that used for the improvement of the beet, namely, seminal selection and chemical examination combined.

It has been suggested in Trinidad some years ago, in Louisiana and elsewhere, that some improvement might be effected by selecting the sweetest canes from certain stools

and raising successive generations therefrom. The weak point in this suggestion, is the fact that the stool must be taken as one individual, and its value must be taken as a whole, and not in part, for the parts vary, but the stool varies less. A low sugar-content cane taken from a stool, might give a high sugar content when grown and well ripened, and *vice versa* for it is a fact that in all kinds of cane no matter of what character or class, some canes in each stool will be found sweeter than others. This is mainly due to their state of maturity, together with the state of the atmospheric conditions prevailing at the time of selection, but more to the former than to the latter, although the general value of the stool is largely influenced by the state of the weather. The riper a cane and the less water it contains, the sweeter it is per cent.; but whether it would maintain its sweetness the ensuing season, would entirely depend upon the state of maturity it then attained and the conditions of the weather, which might hinder or debar it from attaining that maturity. The value of a cane, therefore, depends upon the general average of a stool, and the principle of selection according to the chemically ascertained "general average of a stool," is certainly a better method of progression from all points of view than the selection of individually sweet canes.

In carrying on such work, however, every point which can be advanced deserves the fullest investigation, for no detail is too small, or too insignificant to be neglected. Prove all, prove everything, by scientific proof; and then, if they stand the test or fail, we know whether we are progressing, have upset or confirmed a theory, or have made no way whatever.

Seminal selection must be put in the first place in our work of improvement, for it is certain that we must have the plant before we can give it improved cultivation. It is not intended to discuss at this time the improvement which can be effected by properly directed cultivation and manuring, as that is outside of our present subject, and the methods of cultivation and manuring are quite sufficient in themselves to form the subject of lengthy papers. It has been shown how important it is that the work of directing experiments in the raising and trial of new canes should be well carried out: but it must also be shown how necessary it is that such experiments should be carried on continuously at several centres. It is not sufficient that they should be carried out at a single centre, for the simple reason that individual choice and fancy have a great deal to do with the results which will be attained. Every new cane has to pass in the first instance a field test or choice, *i.e.* the cultivator must judge whether or no it possesses those characters which would enable it to be economically grown for the production of sugar: and in making this selection, every cultivator would have his fancy, or his idea of what a good cane should be like. One cultivator might condemn what another would save, and, therefore, the chances would be that a greater variety of canes would be secured by having several stations, than would be the case if a similar number were grown at a single large station. Again, a cane might prove a very useful variety in one colony, but prove utterly useless in another.

There is a well-known case in point in the "Burke" cane, which is quite useless on Trinidad soils, and *vice versa*, a cane raised in Trinidad might not suit at all the drier climate of the more northern Islands.

Again, the choice of an individual experimenter might fall upon a certain habit, quite suitable for where he is stationed, but useless elsewhere. It is clear, therefore, that the number of observers is a point in favour of a successful issue, for the larger the number, the more likelihood there is of securing a series of useful kinds, provided the procedure is based on similar lines.

I will now discuss the improvement of coffee. Probably few of us have thought out this question of improvement fully. It must be confessed that the more we think of it, the more we are impressed with the possibilities that lie before the experimentalist, and there cannot be the slightest doubt that it is a subject which should occupy the attention of every West Indian cultivator without exception. Let us ask ourselves, what do we know about coffee? What improvements have been made in the quality of coffee? and what efforts have been made or what experiments have been carried out to show the class of plant most suitable for cultivation in the various colonies, in the hills and on the plains?

Most people would confess that little or nothing has been done, not a few would declare that the quality was all that could be desired, and some would no doubt assert that they knew all about coffee Others who have travelled, and have seen other produce besides their own, would know what a variety of qualities there is in coffee, and what an important thing it is to grow only the best if we intend to make our plantations pay.

As a matter of fact, the bulk of the coffee grown in the West Indies is produced by varieties of *Coffea arabica*, some very bad, some very good, some suitable for the soil on which they are grown and some unsuitable.

There are, of course, a few plantations on which Liberian coffee is grown, and the Botanical Departments in the different Colonies have some new species and varieties on trial.

It would not be difficult to show that we should not depend alone upon these, but rather upon what we can produce or raise from them by hybridization and seminal selection.

If on certain areas at each Botanical Station, plants are raised from hybridized or selected seed, and carefully grown so as to show the character, form, and bearing qualities of the individual trees, the process of selection can be brought to bear continuously until the form required is produced. This is no chimera, but actual fact, as can be shown by the work of European raisers of new classes of plants. I can also bear testimony that the same process is possible with coffee. All may not be aware of the progress and extent of the coffee industry in Central American States, especially in Nicaragua. The industry is one of which that country has good reason to

be proud, for the increase is enormous, and the quality of the bean is such that it runs very close the quality of that produced in the Blue Mountains of Jamaica, and probably, if grown at the same elevation, would excel it. This result has been obtained by seminal selection, and by the rejection and cutting out of all inferior kinds. I know one estate where this kind of improvement has been faithfully carried out, and where nothing but what has actually passed through the owners' hands is ever planted, no tree being put into the ground, unless it has been properly trained and brought into shape in the nursery. The result of such good work is plainly evident in the fact that this one estate is sending into the London market a very high class of coffee which is shipped to the value of £20,000 annually. Now, what is the common practice with regard to coffee in most West Indian Colonies? In Trinidad, planters grumble at having to pay even a halfpenny, for well-grown nursery plants, and rather take rat-sown coffee, picked up in the "highways and hedges," because they can obtain it at a slightly cheaper rate, although they know nothing whatever of its quality. A coffee plant to them is a coffee plant, and and they do not seem to have the slightest idea that one class of plants can be better than another. It is necessary, therefore, to show on an experimental field the difference between the bad and the good, the profitable and the unprofitable, and to show that by selection of seed and by hybridization, strains may be raised vastly superior in every respect to the common types which are now planted, and that it will pay the planter to grow such strains even if it costs more in the first place for the plants. There are probably not a few persons to-day in the West Indies who would discredit these remarks and suggestions, but they are none the less true in every respect, and it, therefore, becomes the work of Agricultural Stations to carry on experiments in such a way as to show what great improvements can be made, by the exercise of continuous and judicious effort. It may be a hard task, it may meet with undeserved opposition, but in spite of all this, it is evidently the course to be pursued by all who desire to see the agricultural industries of the West Indies again in a flourishing state, and the intelligence of the community will, I hope, support the endeavour.

With cacao the same principles can be applied. Why they have not been applied hitherto, is a matter hard to understand, but the fact remains, they have not. The only attempt at the improvement of the quality of cacao, is that which has been made by the selection of seed by its external characters, and the import of seed from other countries. The result is that to-day, although the remains of the original types are clearly apparent, it is also clear that, though bringing good prices, the cacao as now grown is, as a whole, nothing less and nothing more, than an aggregation of cross-bred varieties. Some few might attempt to do so, but I think a wise planter would hesitate if he was asked to show where Criollo ended and Forastero began, or where Forastero ended and Calabacillo began.

The fact is, that the cacao of the West Indies is nothing,

more nor less than a mixture of various strains, which again vary in and among themselves in no certain direction, and among which the character of the ancient types appear more or less developed according to the character of their surroundings and the numerous influences which have been brought to bear upon them. The quality of the cacao produced from these strains is variable, some selling for good prices, while other brands are decidedly inferior. The characters of the leaves, the form of growth, the colour and form of the fruit, the size, shape and colour of the interior of the bean are all variable to a degree, and few trees can be found which are the exact counterpart one of the other, either in their produce or their vegetative characters.

There have been no general and well-directed attempts to plant from single trees known to produce high-class cacao, so as to extend the culture of the most profitable kinds, but instead we have had a sort of haphazard practice which admits of the selection of seed from mixed plantations, without properly guarding the seed trees and securing them from cross-fertilization.

It cannot be disputed that there are excellent strains of cacao among these mixed growths, but it must be admitted that there has been little attempt to secure "pure strains" of the best kinds, by selection, so as to secure the production of a brand of cacao in which there could be no mixed beans.

The discovery that cacao can be easily grafted by approach, now puts into the hands of the planter a means whereby he can ensure a crop of one particular kind or kinds at will, and further it will enable him to make samples of a character formerly impossible. It will also enable him, if he finds it profitable, to grow such types as the Criollo or any other weak grower, upon the vigorous growing types of Calabacillo.

When growing from seed, the selection should only be made after due examination of the interior of the bean, as the quality of the finished article can generally be determined by this means. The trees selected as seed bearers should be vigorous, healthy, of good form, and the blossoms should be efficiently protected from cross-fertilization, and if deemed expedient, the flowers themselves should be artificially fertilized. It would then be seen that the produce could be made to come true to a very high percentage, and once plantations of a single type could be brought into existence, their superiority would be so obvious that no further persuasion would be required to have the method generally adopted, as it would be seen to be the most profitable practice which could be pursued. Fields would then be arranged so as to produce a sample of one certain quality, showing no variation in the size or form of bean, or the quality of its interior. It would be possible to have plantations on which not a single red pod could be found, and others on which not a single yellow one could be seen ; or if found desirable, each quality might have its own field, and be given any particular or special cultivation which it might require.

These are the points which should be kept in view and for which we should work, for it is fairly certain that if results are achieved such as I have indicated, there could be no doubt that improvement had been made of no uncertain value.

Turning to what are called "ground provisions," we find that there is actually no general knowledge in one Colony of what the others grow. I do not mean it to be understood, for instance, that Jamaica does not know that Barbados grows yams. That much is known well enough, but it is not known generally in the other Islands what classes of yams, potatos, tannias, peas, cassava, etc., etc., are really grown, except, perhaps, in those islands to which Barbados sells her produce. Any one can prove this by importing, as I have done, various kinds of ground provisions from several of the islands. Moreover, it will be found that, though the produce may be received under the same name, it will, in very numerous instances, differ in quality and general character.

In 1887, I found in Trinidad a sample of arrowroot which could not be made to produce tubers, and I was told that arrowroot could not, in consequence, be grown in Trinidad. I was sceptical of this, and procured roots from St. Lucia. As a result, I proved that the Trinidad plant was a worthless variety, and that arrowroot would grow as well in Trinidad as elsewhere. Yams are almost universally grown, but it will be found that what is a highly prized variety in one island, is surpassed in a great measure by the productions of another. With the tannia (*Colocasia*, the Coco of Jamaica) the same has proved to be the case. The "Commander Coco" of Jamaica is far superior to anything grown in Trinidad, and it can be quite as easily grown. Again, what is known in Trinidad as "dasheen," also a *Colocasia*, is not, I think, grown in Jamaica at all. In the banana tribe (*Musa*), there is in Trinidad a varied selection of material, but the marketable variety or "Gros Michel" was not generally cultivated until it was brought to notice by the Botanical Department in 1888. Now it is generally grown, and may be seen in the markets in most districts.

It will be seen, therefore, that there is special need for making collections of these products at well-situated centres, for the purpose of testing their value, and affording information to the general public. Single Botanical Stations cannot grow everything, their resources are limited; but one might grow yams, another cacao, another would content itself with the improvement of sugar cane, and others might take cassava, arrowroot, etc., etc., and all might assist by sending specimens for trial.

In Trinidad I have had yams under experimental trial for several years. Other Colonies might take them up in turn, and prove on the spot whether the conclusions I have arrived at are correct or not, or whether the conditions of growth are the same in each Colony. It will probably be found that the results will differ somewhat, and that some kinds are more suitable for one Colony than another which is exactly the point we require to demonstrate.

Who has ever raised yam from the seed? Who tannias, or who cassava? Who can tell what varieties might be found among such seedlings? Here, indeed, is an undiscovered country, to which if a traveller goes, it is to be hoped that he will return as heavy laden as did those famous travellers of old from the vale of Eschol, for there cannot be the least doubt that a very rich harvest awaits the labourer who ventures in this direction.

The harvest truly is great but the labourers are few. Success cannot be achieved in a day, progress cannot be recorded in a season; but continuous and careful efforts on the lines I have laid down will, I am positive, result in the improvement of tropical produce, and do a great deal towards bettering the condition of all the West Indian Islands.

I could have extended this paper to a much greater length by mentioning numerous other products which might be improved, but enough has been written, I think, to convince those ready to hear of the need for improvement, and also of the possibility of accomplishing such improvement within a reasonable space of time, by the united efforts of those upon whom the task devolves.

In conclusion I can only express the hope that each and every one who puts his hand to the plough, will meet with all the success that work of such an important character so fully deserves.

DISCUSSION.

The PRESIDENT: Mr. Hart has wide experience of tropical cultivation. He was for many years associated with me in Jamaica, and for the last thirteen years he has occupied the important position of Superintendent of the Royal Botanic Gardens at Trinidad. In connection with these Gardens, what promises to be a valuable experimental Station is in course of being established at St. Clair. I visited the Station in November last and was greatly impressed with the results likely to arise from Mr. Hart's efforts. The plots of seedling sugar canes, coffee, cacao, india-rubber and other economic plants were in excellent condition. Mr. Hart himself has practically started some of the investigations suggested in his Paper. I commend a similar line of inquiry, with the view of assisting in the development of the resources of the West Indies, to all gathered here to-day. It is evident that outside what is being done with the sugar cane, we have not touched the fringe of the useful and important work suggested in Mr. Hart's Paper.

THE PREVENTION OF THE INTRODUCTION AND SPREAD OF FUNGOID AND INSECT PESTS IN THE WEST INDIES.

By William Fawcett, B. Sc., F.L.S.

It is very well known that where plants of one kind are grown together on a large scale, they afford scope for the rapid extension of disease, the consequent destruction of the plants, and, perhaps, utter ruin to planters.

To take an instance of a fungus disease: About 1869 the fatal coffee leaf disease (*Hemileia vastatrix*), hitherto unknown, suddenly developed on cultivated coffee in Ceylon and ultimately ruined the coffee planters there.

It spread almost immediately from Ceylon to Southern India. It reached Sumatra in 1876, Fiji and Java in 1879, Mauritius in 1881, and Natal in 1884.

The coffee industry is of such vast importance in Jamaica that the Legislature passed a law in 1884, empowering the Governor to prohibit the "importation of Seeds or Plants or any description of soil or earth or any article packed therewith, that may have come either directly or indirectly" from any country.

Sir Henry Norman afterwards issued a proclamation in terms of this law against Natal, South India, Ceylon, Mauritius, Java and Fiji.

About two years ago some of the coffee planters in Jamaica became alarmed over a rumour that some one had imported coffee plants from some foreign source. On representations being made to the Governor a proclamation was issued, forbidding the introduction of seeds or plants of coffee from any other source than Kew Gardens, and then only when sent to the Government Botanic Gardens.

Last year it came to my knowledge that seeds of a rubber tree were being sent in large quantities from Ceylon to Antigua, and that negotiations were opened up to pass on a portion to Jamaica. The matter was represented to the Governor who took immediate steps to communicate to the various Governments of the British Colonies the danger involved, and in many of these Colonies proclamations have already been issued against the introduction of seeds and plants from Ceylon. The Governments of the foreign colonies are also taking up the subject, for instance, Guadeloupe has prohibited the importation of seeds and plants from any of the infected countries.

I am informed by the President of this Conference that a bill will shortly be introduced into the Legislature of Barbados to deal with the matter. The danger is not realized, however, everywhere, and I will, therefore, quote from a letter addressed by the Director of Kew to Lord Roseberry in 1893 with reference to a proposed prohibition against the importation into

British Central Africa of *any* seeds or plants likely to introduce the leaf disease. The quotation is as follows:—

"The *Hemileia* is without exception the most destructive fungoid scourge known. It exceeds even the potato disease, because that does not ravage the crop with persistent virulence year by year. The *Hemileia*, on the other hand, when it has settled on a plantation, remorselessly, if somewhat slowly, destroys it. Its action has necessarily largely restricted coffee cultivation in the Old World, and to that extent the risk of transporting it which attends the abundant communication which now takes place between individual colonies, is diminished. Still, sooner or later, the spores will probably be carried across the Atlantic. In the meantime it appears to me to be the interest of every uninfected coffee-growing country to intercept its invasion.

"I am always reluctant to concur in regulations which must have a restrictive effect, even if small, on commercial enterprise. But in the present case it is impossible to accept the risk of ruining an important and developing industry, which is an important factor in the successful colonization of British Central Africa. It appears to me that Her Majesty's Government have no choice but to follow the precedent already set in the case of Jamaica.

"The proposed regulations will, however, require revision. As already pointed out, the whole of the New World is free from leaf disease. South America need not, therefore, be included. On the other hand, the whole of the coffee-growing countries of the Old World appear to be infected. To be of any use, the regulations must include Mauritius, the Straits Settlements, Java, Sumatra, and the Dutch East Indies, as well as the Malayan region generally."

I think that a reference to this special disease is sufficient to illustrate the importance of very carefully considering the whole subject in all its bearings. But I will just refer to the scare caused in the United States and Canada by the spread of the deadly "Scale Insect" called the San José Scale. So sudden has been the spread of this pest, and so deadly is it in its nature, that the Canadian Legislature suspended its standing orders and passed a bill in all its stages in a single day, absolutely prohibiting the importation of plants from the United States, although it was well known that this measure would entail immense loss on some of their own people. In the United States, measures have also been taken in a very vigorous manner against the spread of the pest. Professor Herbert Osborn, in his presidential address last August to the Association of Economic Entomologists of the United States, said

"With the appreciation of the fact that insects are constantly being transported from country to country, and that in many cases their appearance in a new country marks a period of most rapid increase and extended destruction, makes it an imperative duty to devise means for preventing such distribution wherever possible. Whatever we may think as to the possibilities of suppression or the best means to accomplish exclu-

sion, we cannot but agree that such exclusion is the only safeguard against such pests. That the enactment of quarantine laws and adoption of systems of inspection will prove an absolute safeguard none dare contend, but until some surer method presents itself, or it can be shown that this entails more loss than gain, it deserves careful attention, the most painstaking adjustment of laws to conditions in various sections, and a cordial support from the working entomologists of the country."

I will now fully indicate one or two points that might be discussed by the Conference: (*a*) All Nurseries, including those in Botanic Gardens, should be inspected periodically by a botanist and entomologist who should be empowered to recommend the destruction, if necessary, of infected stock, or adopt other means of exterminating any pest, so as to prevent its extension; (*b*) A Law should be passed in every Colony allowing the Governor on the issue of a Proclamation to prohibit the importation of seeds or plants from any other country on reasonable grounds of possibility of infection.

The prohibition need not be general; it might, as has happened in Jamaica, prevent the importation by any other means than through the Botanic Gardens and from some special source, such as Kew Gardens.

In connection with the whole subject, experiments might be made on the influence of various manures and of different conditions on the susceptibility of plants to disease. In recent years something has been done in such investigations. It has been shown, for instance, that particular substances, such as dextrose, have a strong attractive power for bacteria and other forms of fungi. It has been proved again that some fungi which are *not*, as a rule, parasitic, become so, when the plant attacked is in an abnormal condition. This side of the subject is well worthy of special consideration at some future Conference.

DISCUSSION.

The PRESIDENT: The injury done to crops by insect and fungoid diseases in the West Indies is, I believe, steadily increasing. The subject is too large to be dealt with to-day; but the time has arrived when general action must be taken if we are to protect our crops from the destructive influences of pests. In all progressive agricultural communities, such as Canada, the United States and Australia, it has been found necessary to prohibit entirely the importation of plants likely to introduce certain specific and well-known pests. In the West Indies I should hesitate to advise drastic action of this character, but there can be no doubt that the uncontrolled distribution of plants now going on in these Colonies is fraught with danger, and sooner or later steps must be taken to regulate their distribution and where necessary to inspect and disinfect them.

I am satisfied that thousands of pounds are annually lost to cultivators in the West Indies by insect and fungoid pests. Small cultivators, as a rule, abandon their plants when infested with disease and take no steps whatever to prevent the latter from spreading in all directions. So far nothing has been attempted by legislation except to keep out the "coffee-leaf disease" of Ceylon. Jamaica has been chiefly instrumental in this direction. In every Colony where there is a Botanic Institution, the officer-in-charge should keep a vigilant watch for insect and fungoid pests, give warning of their presence and suggest means whereby they can be effectually dealt with. I would also advise that all plants received at Botanic Stations be placed in an enclosure by themselves and kept under a system of quarantine for some weeks until it is quite certain that they are free from pests. Where necessary such plants should be regularly disinfected; or if badly attacked they should be destroyed at once. In the case of annual crops the better plan is to burn everything, sprinkle the land with lime and plant some other crop. Where large trees are affected with "sooty" and other blights, the limbs might be lopped and the prunings burned. Afterwards the main stem and limbs might be disinfected so that the new growth may have a healthy start. This important subject will, I hope, come up again at the next Conference. It is evident that something must be done; but I would deprecate hasty action at present. To start with, I would recommend, as suggested by Mr. Fawcett, that general powers be intrusted to the Governor of every West Indian Colony to prohibit, under scientific advice, the importation of certain seeds or plants when it is known that their introduction would be a source of danger to local industries. This simple machinery would be ready in cases of emergency, but even this need not be used unless circumstances absolutely require it.

Mr. J. H. HART: Having studied this question, I regard total prohibition undesirable, as it stops the run of trade and is ineffective. For instance, if you prohibit against a country, any one could get the plants he requires by having them shipped through a foreign port. It would be no use for Trinidad, for instance, to prohibit against Ceylon or Jamaica if Venezuela (only a few hours sail from Trinidad), is not included in the prohibition. I agree with the President as to the value of a system of quarantine, as I believe it would be much more effective and useful and permanently beneficial. Plants coming from abroad should all be examined or quarantined and, when from new countries, treated with insecticides; but it would be preferable to destroy all badly infected plants. A system of federation of the West Indies for the purpose of quarantining plants would, I believe, prove thoroughly efficacious.

The PRESIDENT: I do not quite follow Mr. Hart's remark that total prohibition will not answer. Canada has decided that the examination of plants from the United States is ineffective because the San José scale is so minute as to occur even in the bud scales. Canada has, therefore, prohibited the

importation of all fruit trees from the States. The measure is, I admit, a drastic one, but it has certainly protected the orchards of the Dominion from an enemy that threatened to destroy them.

Mr. HART: What I stated about total prohibition was that if you prohibit against one country you must prohibit against the whole world. Otherwise plants may be shipped from a prohibited to a non-prohibited country and eventually reach the country where they are not desired, all the same.

The PRESIDENT: It is understood that certificates of origin are in force.

Mr. HART: They may be manufactured.

The PRESIDENT: They are nevertheless regarded, under certain circumstances, as an effective check on undesirable importations. A good deal depends on geographical position. No man, for instance, would, take the trouble to send plants from the United States to Jamaica in order to be able to get them landed in Canada. The voyage to the tropics would probably kill them. What we require in the West Indies is a simple and effective measure of prohibition under intelligent control. Where the risks are considerable, as in the case of the dreaded "coffee-leaf disease" of Ceylon, I am prepared to recommend absolute prohibition.

BRIEF SUGGESTIONS ON COLONIAL INDUSTRIES.

By Professor P. CARMODY, F.I.C., F.C.S.

In one of your circulars referring to this Conference, it is stated that "it is proposed to secure common action in ripen-" ing questions of great importance to the West Indies at the " present time:" and with this object in view, I have collected a few suggestions, which may not be unworthy of your consideration, and on which you might, if not now, at some time subsequent to this Conference give us the benefit of your advice and long experience in the West Indies.

Sugar Manufacture.

I think that it should be firmly impressed upon planters that the manufacture of sugar from sugar cane requires the employment of men especially trained in that art, and that it is useless to hope to obtain the highest yield and quality of sugar under the present system which leaves the cultivation of the cane and the manufacture of the sugar therefrom, entirely in the hands of one manager. However competent he may be in either branch of the industry, it is practically impossible for him to give to both, and especially to sugar manufacture, that close personal attention which the keen competition of the present day demands.

The manufacture of sugar involves that of rum. which also requires special training and attention. The surest prospect of success in this direction is the establishment of central factories.

I should like to ascertain the opinion of this Conference on a few points connected with sugar cane cultivation. In some Colonies, cultivation of the cane excels: in others, the manufacture of sugar: the two are rarely, if ever, combined in any one Colony. Where excellence is shown in either branch, the methods by which it has been attained should be carefully studied and utilized for the benefit of other Colonies so as to secure a general and continuous process of levelling up.

I should be glad to know whether, in the opinion of the Conference, the use of machinery, instead of hand labour, could be advantageously extended under the varying local conditions peculiar to each Colony. My own opinion is that the amount of hand labour that can be profitably employed in cane growing is too limited to meet the requirements of good cultivation.

I would further ask for an opinion on the following points: –

(1) As to the possibility of a rotation of crops with sugar cane, and assuming that possibility, the most saleable crops to raise.

(2) As to the most suitable crop to be used for green manuring, the length of time such crop should be allowed to grow, whether it should finally be covered in in the green state, or burnt and then ploughed in.

(3) Whether "catch crops" are possible, and, if so, what kinds are most suitable.

(4) Whether such methods would be likely to prove the most efficient means of destroying weeds and injurious insects, and of preventing the recurrence of those fungoid and other diseases that so materially reduce the yield of sugar from the canes.

Pen Manure.

In the Colonies there is a gap in the cycle of industries which elsewhere are usually included under the head of farming. As a rule there are but few house-fed cattle here, and consequently very little stable or pen manure. It is of great importance that planters should utilize cattle for the production of pen manure because of its superiority in many respects to artificial manure; and the rearing of cattle, for sale or for draught, should be encouraged as an essential part of the planting industry.

Fruit, Fibre and Starches.

The West Indian Colonies are specially adapted for the growth of certain kinds of fruit, fibres and starches; and if more attention were given to these products, they would probably become very important minor industries.

If our fruit cannot yet be exported for want of cold stor-

age, we should in the meantime encourage other industries in which the fruit might be utilized. Liqueurs could be made from lime juice, sugar and rum products entirely tropical; and, if successful, might create a large local demand for limes and similar fruits which are now wasted in large quantities. I think falernum is a liqueur which, if better known in Europe and America, would command a large sale. Lime juice syrup should be made at every island as it is at Montserrat. The preservation of fruit in sugar should also be properly taught and encouraged. At present its slovenly crudeness condemns it.

The proper preparation of starches for European markets is a subject which requires attention, and the methods in use in places like Bermuda, in the preparation of arrowroot, should be imitated.

Foreign Markets.

It is of primary importance to secure the most favourable conditions for the sale of tropical produce in the English and foreign markets.

The important question of freight and other charges incidental to the conveyance and landing of produce in foreign markets should receive attention. The freight charges on colonial produce are heavy, owing largely to the great distances at which suitable markets are situated.

The substitution in European markets of a dyed imitation of the well-known West Indian product (usually sold under the name of Demerara sugar) has inflicted losses on the West Indian trade to an extent which cannot easily be estimated.

The additions of very large proportions of starch and sugar to a relatively small proportion of cocoa, and the sale of the mixture as "prepared cocoa" without any intimation as to the percentage of cocoa it actually contains, is another instance of a loss that contributes to the depression of West Indian industries.

Food inspectors and analysts in England have endeavoured to check these adulterations; but it is obvious that the present Food Adulteration Acts cannot give that amount of protection which the importance of the wide and far-reaching issues involved demands.

It is worth while for planters to consider whether a West Indian trade protection association should be started and experts appointed as inspectors, whose special duty it should be to make detections and conduct prosecutions under the Food and Drugs or Trade Marks Acts, on the lines now successfully practised by the Bacon Curers Association.

DISCUSSION.

The PRESIDENT: Professor Carmody has introduced many points worthy of careful consideration between this and the next Conference. Some information has already been collected on the substitution of machinery for hand labour in the cultivation of sugar cane. In some of our Colonies, especially those suffering from want of labour, suitable machinery would prove

of great advantage in cheapening production. Some of the rotation crops for sugar estates have already been indicated by Professor Harrison in his British Guiana Reports; while recently in the *Kew Bulletin* (1898, pp. 207—208), attention was drawn to a large number of tropical leguminous plants used for green manuring. In Mauritius the system of green dressing is apparently carried out more fully than in the West Indies, though a good deal of attention has been devoted to the subject in St. Kitts for the last few years. The excellence of Bermuda arrowroot, I may mention, is attributed as much to the pure water used as to the careful methods of manufacture. The remunerative sale of West Indian produce is a subject which should be energetically taken up. I entirely sympathize with efforts now being made in that direction.

CONCLUSION.

The PRESIDENT: We have now reached the concluding stage of the proceedings of the first Agricultural Conference held in the West Indies. It is my pleasing duty to convey the hearty thanks of the Conference to those gentlemen who have so generously devoted valuable time in the preparation of papers, and to those who have taken part in the discussion. The time for preparing papers was necessarily very short and that renders our obligation all the greater to those who so readily responded to my appeal. I believe the proceedings of this Conference will form a valuable record of the efforts now being made to improve the circumstances of the West Indies; while next year, if we are spared to meet, we shall start with a wider view of the prospect before us and be better equipped to discharge the duties intrusted to us.

Rev. WM. SIMMS in moving a vote of thanks to the President said: Sir, Before we close I wish to undertake the pleasant duty of proposing a vote of thanks to yourself. This is in many ways an important occasion. I believe I am correct in saying it is the first time in which the whole West Indies have met in council, officially, on any subject whatever (Cheers). The Archbishop of the West Indies was in the habit of saying that he was the only individual who had an official connection with the whole of the West Indies; but now, Sir, there is another in the person of yourself, who has an official connection with all these colonies. Speaking for the West Indies, I may say we were extremely delighted when we found that the Imperial Government were taking up our cause: that they realized the gravity of the situation, and intended to make efforts to meet it. We feel that you, Sir, represent to us in this matter, the sympathy of the Imperial Government; and we also feel that you represent to us a bond of union that needs to be drawn closer and closer between the various colonies of the West Indies. I think we have every reason to be pleased at having a representative of the Imperial Government sitting in the chair of this Conference. But apart from that, we in Jamaica at any rate, did feel very great pleasure when we learnt who was the Commissioner appointed to preside over

the Imperial Agricultural Department in these Colonies. We felt delighted in the person appointed. We felt that a man most fitted for the post had been appointed. We also wish to express great thanks to yourself and your assistants for the great trouble which you must have taken to bring about this Conference, and in overcoming the difficulty of getting persons to come here from all parts of the West Indies. In every way in which we look at it, from your official position, the personal work you have done in the tropics, your kindness as Chairman, and the extremely able way in which you have managed the business of the Conference, I am quite sure I have with me the feeling of every one present in moving a vote of thanks to the President of this Conference. (Loud cheers.)

Professor CARMODY in seconding the motion said so much had been said, and well said, by the Rev. W. Simms, that there was little left for him. He ventured to hope, however, that this Conference would be the beginning of a new life for the West Indies, and would prove the most important event since the islands were discovered by Columbus.

Dr. MORRIS in acknowledging the vote of thanks said:

The task of organising and making the arrangements for this Conference was undertaken from the first with the cordial support of the Secretary of State, and it is largely owing to the personal interest taken in it by Mr. Chamberlain that the Conference has proved so successful. I may also mention the hearty co-operation of the several Governments in the West Indies who at some inconvenience and expense to themselves have spared the services of the heads of Departments and given them permission to take part in these proceedings. I may add that we are specially indebted to His Excellency the Governor and the Government of Barbados for the hospitable reception the members of the Conference have received and for the use of this handsome hall as a meeting place. For myself I need only say that I am fully rewarded for the share I have taken in the Conference by the very appreciative words that have fallen from the mover and seconder of the resolution and the more than kind way in which you have endorsed them. I have to thank you heartily for the valuable assistance and support you have given me as President, and I trust that at any future Conference that may be held in the West Indies the same spirit of cordiality and the same earnest desire to further the interest of these colonies will be shown as has been shown at the Conference of 1899.

AGRICULTURAL CONFERENCE, 1900.

THE SECOND WEST INDIAN AGRICULTURAL CONFERENCE was opened on the 6th January last, in the Hall of the House of Assembly, Barbados, under the presidency of Dr. D. MORRIS, C.M.G., Imperial Commissioner of Agriculture for the West Indies. There were forty Representatives present, including the heads of all the Botanical, Chemical, and Educational Departments, as well as Representatives of the principal Agricultural Societies in the West Indies. The Governor of Barbados, Sir James Hay, K.C.M.G., Sir George Pile, Kt., Sir Conrad Reeves, Kt., the Members of the Legislature and the principal planters were also present. The following is a list of the Representatives appointed by the several West India Governments to attend the Conference:

JAMAICA.

The Director of Public Gardens and Plantations (WILLIAM FAWCETT, Esq., B.Sc., F.L.S.)

The Acting-Superintending Inspector of Schools (GEORGE HICKS, Esq.).

The Principal of University College, Kingston (Rev. Canon SIMMS, M.A.)

BRITISH GUIANA.

The Government Analyst and Professor of Chemistry (Professor J. B. HARRISON, M.A., F.I.C., F.G.S., F.C.S.)

The Government Botanist and Superintendent of the Botanic Gardens (G. S. JENMAN, Esq., F.L.S.)

The Acting-Entomologist to the Government of British Guiana (J. J. QUELCH, Esq., B.Sc.)

The Principal of Queen's College (J. A. POTBURY, Esq., M.A.)

The Inspector of Schools (WILLIAM BLAIR, Esq.)

The Botanical-Assistant-in-charge of Sugar Cane Experiments (ROBERT WARD, Esq.).

The Agricultural and Technical Chemist, Plantation Diamond (WILLIAM DOUGLAS, Esq., F.I.C., F.C.S.).

Representative of the Royal Agricultural and Commercial Society of British Guiana (FREDERICK J. SCARD, Esq., F.I.C., F.C.S.).

TRINIDAD.

The Government Analyst and Professor of Chemistry (Professor P. CARMODY, F.I.C., F.C.S.).

The Superintendent of the Royal Botanic Gardens (J. H HART, Esq., F.L.S.)

The Acting-Inspector of Schools (J. H. COLLENS, Esq.)

The Principal of the College of the Immaculate Conception. (Rev. W. CAROLL).

The Curator of the Botanic Station, Tobago (HENRY MILLEN, Esq.)

Representative of the Trinidad Agricultural Society, (Rev. Dr. MORTON.)

THE WINDWARD ISLANDS.

The Curator, Botanic Station, Grenada (W. E. BROADWAY, Esq.)

The Inspector of Schools, Grenada (J. HARBIN, Esq.)

The Curator, Botanic Station, St. Vincent (HENRY POWELL, Esq.)

The Officer-in-Charge of the Agricultural School, St. Vincent (MURDO MCNIELL, Esq.)

The Acting-Inspector of Schools, St. Vincent (MILES L. PHILLIPS, Esq. B.A.)

The Curator, Botanic Station, St. Lucia (J. C. MOORE, Esq.)

The Agricultural Instructor, St. Lucia (GEORGE S HUDSON, Esq.)

The Inspector of Schools, St. Lucia (F. E. BUNDY, Esq.)

LEEWARD ISLANDS.

The Government Analytical and Agricultural Chemist (The Honourable FRANCIS WATTS, F.I.C., F.C.S.).

The Curator, Botanic Station, Dominica (JOSEPH JONES, Esq.)

The Officer-in-Charge of the Agricultural School at Dominica (D. TANNOCK, Esq.)

The Curator, Botanic Station, Antigua (W. N. SANDS, Esq.)

The Agricultural Superintendent of Sugar Cane Experiments, Antigua (F. R. SHEPHERD, Esq.)

Representative of the Antigua Agricultural Society (A. P. COWLEY, Esq.)

The Curator, Botanic Station, St. Kitts-Nevis (WILLIAM LUNT, Esq.).

BARBADOS.

The Acting-Chairman of the Education Board (The Honourable W. H. GREAVES, Q.C.)

President of the Barbados Agricultural Society (The Honourable Sir GEORGE C. PILE, Kt.).

Representative of the Barbados Agricultural Society (His Honour F. J. CLARKE.)

The Head Master of Harrison College (HORACE DEIGHTON, Esq., M.A., F.R.A.S.)

The Island Professor of Chemistry in chemical charge of Sugar Cane Experiments (Professor J. P. D'ALBUQUERQUE, M.A., F.I.C., F.C.S.)

The Agricultural Superintendent of Sugar Cane Experiments (J. R. BOVELL, Esq., F.L.S., F.C.S.)

The Inspector of Schools (Rev. J. E. REECE, M.A.)

The Assistant-Professor of Chemistry (RALPH RADCLYFFE HALL, Esq., B.A.)

Among those present at the opening ceremony were His Excellency, the Governor, Sir JAMES HAY, K.C.M.G.; The Chief Justice, (Sir CONRAD REEVES); The Colonial Secretary (Hon. RALPH WILLIAMS); The President of the Legislative Council (Hon. Sir GEORGE PILE); The Speaker of the House of Assembly (His Honour F. J. CLARKE): The Master in Chancery. (Hon. W. K. CHANDLER); Hon. THOMAS KERR, C.M.G.; Auditor General (E. T. GRANNUM, Esq.); Colonial Treasurer, (W. L. C. PHILLIPS, Esq.); Hon. W. P. LEACOCK, M.L.C.; The Chancellor of the Diocese, (FOSTER ALLEYNE, Esq.); Very Revd. Dean PHILLIPS; Chairman of the Chamber of Commerce, (J. GARDINER AUSTIN, Esq): W. D. SHEPHERD, Esq.; J. J. LAW, Esq: C. T. COTTLE, Esq., M.C.P. and H. E. BOYLE, Esq., Vice-Presidents of the Agricultural Society: Hon. E. B. COLVIN, M.L.C.; G. LAURIE PILE, Esq., M.C.P.; C. J. GREENIDGE, Esq., M.C.P.; H. W. LOFTY, Esq., M.C.P.; R. J. CLINCKETT, Esq., M.C.P.; Hon. TIMOTHY YEARWOOD, M.L.C.; G. LINGWOOD, Esq.; W. A. HORNE, Esq. (Colonial Bank); Commander OWEN, R.N.R., (Superintendent Royal Mail Company): E. L. SKEETE, Esq.; H. E. THORNE, Esq.: E. E. H. THORNE, Esq., F.I.C.; W. T. ARMSTRONG, Esq.; S. J. FRASER, Esq.; W. H. SMITH, Esq. The following officers of the Imperial Department of Agriculture were present:— the Travelling Superintendent, Mr. G. WHITFIELD SMITH; the Entomologist, Mr. HAROLD MAXWELL-LEFROY, B.A.; the Lecturer in Agricultural Science for Barbados, Mr. ALBERT HOWARD, B.A.; the Lecturer in Agricultural Science,

for Jamaica, Mr. W. R. BUTTENSHAW, M.A., B. Sc.; Mr. B. MASON; Miss B. ROBINSON and the Acting-Secretary to the Conference, Mr. A. G. HOWELL.

The Representatives were received in the Hall of the House of Assembly at 10.30 a.m., by His Excellency the GOVERNOR, who opened the Proceedings by the following speech:

LADIES and GENTLEMEN: It is with great pleasure that I open the proceedings on this occasion and I congratulate Dr. Morris on the support he has received as proved by the large number of representatives assembled from all parts of the West Indies, and on behalf of this Colony I offer them a most cordial welcome. The meeting this year is, I consider, of special interest, for not only are the highest scientific authorities present but, I am glad to say, we have with us representatives of all the principal Agricultural Societies in the West Indies. Thus Science and Practice are closely associated, as they undoubtedly should ever be, for valuable as is a Conference of Experts, the best results can only be obtained when those interested in the practical side of the questions considered also take part in the deliberations. As will be seen from the Agenda Paper there are many subjects of importance to be discussed and our time is very limited. I shall therefore without further preface request Dr. Morris to proceed with his address:—

THE PRESIDENT'S ADDRESS.

Dr. MORRIS then rose and said: I regard it as a great privilege to meet you, as the chosen Representatives of the West Indies, in Conference to-day. I appreciate deeply the action of the several Governments in sparing the services of their officers to attend this Conference and no less the Government of Barbados for its continued hospitality in lending us the use of this Hall as a meeting place.

Not only is every Colony prominently represented by those engaged in Botanical, Chemical, and Educational efforts in the West Indies but we have, also, amongst us gentlemen deputed to attend in behalf of the principal Agricultural Societies in these Colonies. We have, therefore, not only official but non-official representation. This should tend to give our deliberations a wider scope and bring them into closer sympathy with those actually engaged in agricultural pursuits.

I regard your presence here as a proof that you share with me in realising the grave character of the present circumstances of these Colonies. Also, of your earnest desire to do all in your power to improve them by the special knowledge with which each of you, in his own particular branch, is equipped. Many now present were here last year and since that time they have, I know, been busily engaged in carrying out some of the recommendations then adopted. I doubt not that, by such efforts, we shall, before long, do much to increase the material prosperity of these Colonies.

In reviewing the work of the past year, there is much to encourage us; but on the other hand, I frankly admit, we are more and more sensible of the enormity of the task before us,

and the need for active and united action to overcome the difficulties which confront us.

I believe no single agency is likely to prove so useful in this direction as these Conferences. It is recognised that isolated and individual efforts, however earnest and judicious, are bound to flag and, sooner or later, to be abandoned. The *vis inertia* in the West Indies is too great to be overcome by merely spasmodic efforts. Hence, the suggestion of these Conferences. We have here an opportunity of renewing and strengthening our forces: and, after careful consideration, of utilising them to the best advantage. There are also the indirect benefits likely to arise from these Conferences the result of friendly intercourse and a mutual exchange of ideas amongst those engaged in a common work. It would, I admit, add to the interest and value of these Conferences if we could change our meeting place and visit each Colony in turn. At present, at least, I regret to find this is not practicable. It would not only extend the period during which Representatives would require to be absent from their duties, but it would increase their expenses nearly three-fold.

Under existing arrangements attendance at the Conference involves an absence, in the majority of cases, of scarcely a week. If the Conference were to meet as suggested at Trinidad, British Guiana, or Jamaica, it would require an absence of nearly three weeks. An annual Conference under these circumstances would be impossible.

In closing these introductory remarks, I would draw attention to the list of subjects to be dealt with at this meeting. Several are of considerable interest and importance. I am greatly indebted to those who have kindly prepared papers, and I trust that in the course of the discussion following them we shall have placed before us, necessarily in a brief form, as our time is limited, the views of all who have practical knowledge of the points at issue.

SUGAR INDUSTRY.

The most prominent of the recommendations made by the Royal Commissioners for building up the prosperity of the West Indies was the "restoration of the sugar industry to a condition in which it could profitably be carried on." In the address last year I stated that the Department, over which I have the honour to preside, fully recognised this duty and was prepared to discharge it faithfully and zealously. The prominence again given to the sugar industry in the proceedings of this Conference indicates the desire to continue this work.

During the last twelve months Sugar-cane experiments have been carried on in all of what are termed the "Sugar Colonies.": Some of them have already shown distinct promise of success. The experiments hitherto carried on at British Guiana under Professor Harrison and Mr. Jenman are to be extended by means of an Imperial grant approved by the Secretary-of-State. The results of those at Trinidad, started some time ago by Mr. Hart, have now, for the first time, been carefully

worked out by the principal Chemical and Botanical Officers in the Colony. The experiments at Barbados under Professor d'Albuquerque and Mr. Bovell have been expanded into 12 experiment stations, covering in all about 140 acres, to include this year an extra Manurial station and an Irrigation station, the latter for testing, under special conditions, the chemical selection of "seed" canes. At Antigua and St. Kitts, Mr. Watts has in hand experiments, likely shortly to be extended, to fulfil the most immediate requirements of planters in those islands. In Jamaica, there has lately arisen a very considerable demand for new canes which are supplied from the collections at the Hope Gardens. As soon as the services of a competent Agricultural Chemist are obtained sugar-cane experiments on systematic lines could also be started in that Colony.

New seedling canes continue to be raised in most Colonies. Their merits, so far as known, are fully given in Reports issued locally. The Barbados Seedling No. 147, prominently referred to at the last Conference, has fully maintained its position in this island, and after six year's experience is regarded by planters as a most valuable variety. Under favourable conditions of soil and climate, the amount of available sugar contained in it at Barbados is at the rate of 3½ tons of sugar per acre. As illustrating what the planters think of this cane I quote the following from the fortnightly summary of the *Barbados Agricultural Reporter*, December 23, 1899: "The ups and downs of this season's rainfall has enabled us to study more closely the behaviour of the new varieties under the stress of continued dry weather. So far it certainly appears, that in the matter of endurance, as well as in many other good points, B. 147 clearly takes the lead. Where planted with other varieties the contrast is strongly in its favour. A midland planter, who is a very close observer, found in a mixed field of White Transparent and B. 147, that the latter had, on the average, about double the number of stout canes to the hole no small advantage when we consider the sugariness of the new variety – for the difference may be measured by many tons of sugar. B. 147 has, too, the inestimable advantage of being a rough cane outside, with a tough rind, and covered with a coating of dry leaves, which however drops off readily when the cane is fully ripe or cut. A spot of this cane, which we saw lately cut for plants, was remarkably free from the common cane-borer of which it was very difficult to find even a single specimen." There are other promising canes such as B. 109 which, in some districts, has yielded excellent results. A Demerara cane (D. 145) after experimental trials extending over 5 years has twice shown results surpassing even those of B. 147. It is apparently very susceptible to drought. B. 156, a cane with a high average yield, has shown, on an average of 5 years, available sugar at the rate of 7,302 pounds per acre. About twelve varieties in all are under experimental trial on plots of several acres, distributed over the island, under the ordinary conditions of estate cultivation. In addition there are several varieties taken up by private planters. The Bourbon cane, until a few years ago almost exclusively cultivated here, has now been discarded in favour of new varieties.

In addition to raising new varieties from seed, experiments are in hand with canes raised as the result of "bud variation" or sport. A striking instance of this mode of variation in a red ribbon cane was obtained last year. A drawing of the original cane, as also of the sport derived from it, is shown to-day. Also of canes grown from the latter. According to Professor Harrison "the best seedling varieties at Demerara have been obtained from the *red-ribbon cane*." This indicates a special susceptibility of variation in this cane both in seedlings as well as in sports.

There are still numerous problems to be solved connected with the production and selection of new canes. Some will be brought before you to-day. It is evident that, as yet, we are only on the fringe of a great subject. If eventually we are as successful in improving the cane as European nations have been in improving the beet, we need not despair of the future of the cane industry in these Colonies—provided, however, the manufacture of the sugar is carried on with equally improved methods.

SUGAR FACTORIES.

Outside British Guiana and Trinidad we are still confronted in these Colonies by difficulties in extracting all the juice from the canes and in making high class sugar at a cost that will enable the planters to compete successfully in the markets of the world. It is universally admitted that this can only be done in the sugar islands of Barbados, Antigua and St. Kitts, by the establishment of what is known as the Central Factory System. Several attempts were made last year to deal with this subject, but, so far, nothing has been actually done. We have, however, gathered a considerable number of facts, many of them new, on which to base future action. In Barbados the general feeling appears to be strongly in favour of starting a Factory on a co-operative system. The planters are confident, "from the information put before them as to the cost of a well equipped Central Factory, that with the capital obtained on favourable terms and with careful management, co operative central sugar factories would ensure the sugar industry of the island being profitably carried on." They sum up the result of their enquiry as follows: "That, with a co-operative central sugar factory, erected at a cost of say £60,000, paying interest at 3 per cent, sinking fund at 3 per cent., and depreciation fund at 4 per cent., it would be possible to pay the planters 10s. per ton for their canes as an advance to enable them to pay their way until the end of the reaping season, leaving a profit of £15,719 to be divided among them, this profit being equal to an additional 6s. 7d. per ton of canes, or altogether 16s. 7d. After the sinking fund has redeemed the capital the charge for interest and sinking fund would cease, increasing the profit by £3,600 per annum, equal to 1s. 6d. per ton of canes, making a total of 18s. 1d. The depreciation fund would be available for repairs and improvements, thus ensuring that the factory would be in good order up to date when it became free from all charges. There is strong reason to be-

lieve that a factory could be erected for less than £60,000."

This it is admitted represents the working of a Central Factory in its most favourable aspect. But in any case if the planters obtain a substantial increase on their present returns the stability that would be given to the industry in being able to produce high class sugars suitable for all markets, instead of as now, suitable only for one market, and that a precarious one, would be a considerable gain to the island.

The general expression of opinion in Barbados, is contained in the following extracts from a Petition presented by the Barbados General Agricultural Society to the General Assembly in May last :—"That the question of Central Factories as applied to the sugar industry of this island has been carefully inquired into again by a Committee of this Society in connection with the recent visit of Sir Cuthbert Quilter and Sir Neville Lubbock, and that the conviction has deepened in the minds of all who have considered the matter that Central Factories are not only absolutely necessary for the maintenance of our sugar industry, but may be relied on for reinstating it on a sure basis: provided they are worked on a co-operative system. For if such Factories are erected by outside capitalists a very large proportion of the increased profit expected from their erection would be spent out of the island, whereas if erected on a co operative system by groups of landowners as provided for by the Act passed by Your Honourable House in 1895, a considerable proportion of such additional profit would be spent locally, and all classes of our community be thereby benefited.

"That your Petitioners have reason to believe that the landowners of the island are desirous of improving their system of manufacturing sugar and that they would gladly co-operate to do so if capital could be obtained by them on favourable terms, such as would be possible if Your Honourable House would pass an Act to enable it to be obtained under guarantee of the Government of this island."

At Antigua, the question of Central Factories appears to have presented a simpler aspect than in Barbados. It is understood that most, if not all, the leading planters there have already agreed to accept 12s. per ton for their canes delivered within a given distance, and to engage to supply the factory continuously for a period of at least ten years. There is to be a division of profits between the factory and the planters beyond the amount actually required to pay interest, provide a sinking fund and allow for depreciation of machinery. If all the conditions are fulfilled, the factory is ultimately to become the property of the planters. In the course of the discussion on Central Factories this afternoon it is probable that the subject will be more fully presented to you.

REDUCING COST OF CULTIVATION.

Side by side with the raising of new canes and the cheapened and improved manufacture of sugar, we have to consider the reduction of the cost of cultivation. For instance, at present, it is estimated that the system of manuring adopted at

Barbados costs at the rate of £6 per acre per annum. Whether this large expenditure is absolutely necessary can only be decided after careful and exhaustive experiment. Efforts in that direction are now being made It may be possible, but it is not yet proved, that a good deal of the artificial manure now applied to the land is not really effective in producing a corresponding extra yield of sugar. Similarly with the costly system of pen manuring now employed.

A re-examination of the value of green manuring as an economical means of fertilising cane lands, deserves careful consideration.

It has long been known that the fertility of arable land was greatly increased by occasionally growing leguminous crops such as beans and peas. The practice has already been followed in the West Indies. Since Hellreigel discovered a few years ago the scientific explanation of the part played by leguminous crops in fixing the free nitrogen of the air, the subject has assumed great importance. It is possible, by using exactly the right plants and treating them in the most advantageous manner, that we shall find in green manuring a means of enriching cane soils at a comparatively small cost. Mr. Bovell will read a paper which I trust will lead to a useful discussion on the subject. There will also be shewn numerous specimens of leguminous plants, with nodules and tubercles attached to their roots and a slide shewing the microscopic organisms inhabiting them having the power of fixing atmospheric nitrogen and thus enriching the soil.

The cost of cultivation may also be reduced by increased attention to rotation and catch crops, thus growing to a larger extent than at present the food-stuffs and supplies imported from other countries.

During seasons of drought there is often a scarcity of food for cattle and horses. It has been suggested that by the general use of silos, already existing on some estates in this island, large quantities of valuable fodder, now lost, could be preserved in excellent condition. Mr. E. E. H. Thorne will read a brief paper and give his own experience on this subject. Again, in Queensland, dairying is being taken up in connection with cane-farming. The two industries appear to be mutually beneficial. Not only does the milk find a remunerative market, but the manure from the cattle consuming the cane tops greatly improves the land. With dairying again pig-raising is associated and apparently with very profitable results. Tropical Queensland a few years ago produced no sugar. It now produces, not only 164,000 tons of sugar, chiefly by white labour (for by the last returns there were only 7,000 Kanakas in the Colony) but it exports condensed milk, bacon and hams. The production of the latter in 1898, was nearly seven million pounds.

SUBSIDIARY INDUSTRIES.

Next to Sugar, Cacao is the most important production of the West Indies. Trinidad is probably more noted for its cacao than its sugar. "During the last 20 years" according to the official returns "while there has been a net decrease in the

value of the sugar exports of £712,614 there has been a net increase in the value of the cacao exports for the same period of £1,218,522."*

The prosperous little island of Grenada is wholly dependent on cacao and spices. The exports of cacao are of the annual value of £130,000 to £160,000. Of the spices (nutmegs, mace, cloves &c.) about £20,000 annually. Cacao is also grown in St. Lucia and Dominica. The exports in each of the latter islands in 1898 were over one million pounds of the value of about £30,000.

Where suitable conditions exist for cacao growing it is an industry that offers remunerative returns and deserves to be encouraged. It requires little labour, compared with sugar, and is adapted for both large and small cultivators. No special appliances are required for curing, and the demand is steadily increasing.

At Grenada, St. Lucia and Dominica where many small cultivators have already established patches of cacao it is proposed to afford advice and assistance by means of travelling instructors, and establish experiment or model plots in each district, as object lessons in right methods of cultivation. It is believed, if this were done, the exports of cacao would be greatly increased in Grenada and more than doubled in St. Lucia and Dominica within a short period. Sir Alfred Moloney, who takes a deep interest in the work of this Department, has referred to the subject as follows:

"In connection with the Imperial Department of Agriculture he wished to allude to a scheme that had lately been brought forward, which, if realised, he felt confident would prove in the future an essential factor in the improvement and development of the various economic cultures of Grenada. It was proposed, he said, to establish model patch gardens or experiment stations as object lessons in the different parishes and districts. The present time was most opportune for the initiation of such a scheme: the Agricultural Society was vigorous and flourishing, its members were energetic and influential and if this idea were taken up and carried out by them, it would confer a lasting benefit on the entire agricultural community of the island. In order to be placed in a position to carry such a project into effect he understood that the Department would be ready to extend, say to an acre of cacao in each parish placed for the purpose at its disposal for a certain number of years by the proprietor, but continued to be worked by the owner, that expert attention, advice and control which would result in the maximum crop derivable from the culture. He did not think it necessary to enlarge on the benefits to every section of the Agricultural community that must accrue from the establishment of such model gardens or experimental stations, if established in suitable places and easy of access to the agricultural population."

A striking instance of what may be done to assist small cacao cultivators exists in the island of Tobago. As the result

*Report of the West Indian Royal Commission, 1897, p. 102, par. 147.

of the employment of a Cacao instructor (at £84 per annum) Crown lands that up to a few years ago had been entirely unproductive are now yielding crops of the value of £2,000 annually. It is evident the only way to reach the small cultivator in country districts is to carry knowledge to him and give him practical field instruction on the lines pursued in Jamaica and so clearly described by Mr. Fawcett at the last Conference. (*West India Bulletin* vol. I. pp. 108-111.)

In British Guiana where cacao was formerly largely produced by the Dutch and where, according to the Government Botanist, "with due selection of situation and soil few countries are better adapted to cacao cultivation" there is an excellent opening for similar instructional efforts amongst small cultivators.

Coffee cultivation, of late, has been discouraged by low prices. A new estate of about 200 acres has lately been opened at Dominica by a Ceylon coffee planter, at an elevation of 2,500 feet. The result of this effort will be watched with interest. If successful, Dominica should regain its former position as producing some of the finest coffee in the New World. The returns on first class coffee grown in the Blue Mountains of Jamaica have been little affected by the recent fall in prices.

A regular plantation of india-rubber trees, the first in the West Indies, is being established at Tobago by Mr. Esmè Howard. The species selected is the Central American rubber tree, locally known as "Ule" or "Caucho" (*Castilloa elastica.*) It was recently reported that this tree was found wild in Cuba. This is evidently an error. Rubber trees are being planted in small plantations and in isolated groups also in Trinidad and Jamaica. The cultivation could be successfully established in some localities in British Guiana where, already, one or more valuable species are found in a wild state.

Fruit cultivation still continues to expand in Jamaica. With other subsidiary industries it is now of the annual value of nearly half-a-million sterling. In other parts of the West Indies it is impossible to establish an export in fruit without suitable means of shipping it to a reliable market. Inter-colonially much more should be done with fruit. This might afterwards lead to a regular fruit business with the United States and Europe. Grenada, St. Vincent, St. Lucia, Dominica and Montserrat could grow fruit with great success. In the cultivation and selection of fruit as, also, in handling and packing it, a complete change must take place before West Indian fruit (especially oranges, pine-apples &c) can compete with produce from other countries. As Herrick has it:

"If little labour, little are our gains:
Man's fortunes are according to his pains."

It is a singular circumstance that Australian oranges now find their way, on board the Royal Mail Steamers, all the way to the West Indies. Their chief merit is that they are available in the off-season; and, further, they are always carefully selected, and packed and shipped in small, handy cases.

During certain seasons of the year a considerable demand for certain classes of produce exists at St. Lucia, by people employed on military and harbour works, at Barbados for fruit and vegetables not grown in the island, and at Trinidad and British Guiana for those employed on sugar estates. Supplies could be shipped from the Virgin Islands, Anguilla, Montserrat and Dominica. Careful enquiry is being made with the view of developing this branch of inter-colonial trade. Possibly by publishing weekly information respecting the requirements of each Colony and the prices paid, something could be usefully done in this direction. It is proposed to appoint local agents to supply authentic particulars and give hints as to what is actually required. This would tend to save disappointment and loss to the shippers.

AGRICULTURAL EDUCATION.

A careful study of the subject of Agricultural Education appears to show that the tendency of the existing educational system in most, if not all, of the West Indian Colonies, has been to give the peasant a dislike for manual labour and to disassociate him from the cultivation of the soil. This has no doubt been, primarily, due to the absence of suitable training on the part of the teachers and to the educational methods in these Colonies following too closely those of the British Isles. It is inconceivable in communities so closely interested in the cultivation of the soil that Agriculture should not only have been entirely neglected but that the encompassment of school life should have discouraged attention to it. Owing to the early period at which many of the children are removed from school and the irregularity of their attendance, it is not possible that much, if any, direct teaching in agriculture or what has been called "farming" can be given in elementary schools. What is first required is that a series of object lessons be given by intelligent and sympathetic teachers in all classes of schools so that, to adopt the words of the Archbishop of the West Indies, "the entire youth of these purely agricultural communities should be trained in an atmosphere favourable to agriculture, that they should grow up interested in it and that they should learn that tilling the soil and caring for crops is a work worthy of being studied by intelligent minds and likely to lead to greater health as well as greater profit than the purely clerical work which is now so keenly sought for by the more capable peasant boys in the West Indies."

The scheme of agricultural instruction suggested to meet the immediate requirements of elementary schools aims first of all at rendering the existing teachers competent to give simple object-lessons bearing on Agriculture and illustrate them by experiments and actual specimens. Examples of growing plants should be grown in pots and boxes under the eyes of the children and every stage of their growth as well as the conditions favourable for rapid and successful development should be clearly explained. This much is within the reach of the poorest school in the West Indies. All, however, depends on the amount of knowledge and the interest thrown into the subject on the part of the teachers. It is proposed to assist the

teachers at present in charge of schools by affording them the means of attending courses of lectures during their holidays. While attending these lectures, all out of pocket expenses, (except in British Guiana, Trinidad and Jamaica) are paid by the Imperial Department of Agriculture. Lectures to elementary teachers were started last year at Trinidad, St. Lucia and Barbados. In each case with singular success. They will be continued next week at Tobago, Grenada, St. Vincent and Dominica. The teachers so far have shown themselves most anxious to acquire knowledge of the principles of Agriculture and it is anticipated that during the next two years most of the existing teachers throughout the West Indies will have passed through the initial course of training. The teachers now at the training colleges and all future students passing through such colleges should be fully instructed and be competent to teach Agriculture before they are placed in charge of schools. For the present, Blackie's "Tropical Readers," Books I and II, are recommended for use in schools, but great care is required to prevent mere book knowledge, which is worthless taking the place of the intellectual education and the hand and eye-training necessary for agricultural pursuits. To explain clearly what should be aimed at in this connection, I cannot do better than quote from a publication recently issued by the French Government on the "Teaching of Elementary Ideas of Agriculture in Rural Schools":

"Instruction in the elementary principles of agriculture such as can be properly included in the programme of primary schools, ought to be addressed less to the memory than to the intelligence of the children. It should be based on observation of the everyday facts of rural life, and on a system of simple experiments appropriate to the resources of the school, and calculated to bring out clearly the fundamental scientific priciples underlying the most important agricultural operations. Above all, the pupils of a rural school should be taught the reasons for these operations, and the explanations of the phenomena which accompany them, but not the details of methods of execution, still less a résumé of maxims, definitions or agricultural precepts To know the essential conditions of the growth of cultivated plants, to understand the reasons for the work of ordinary cultivations, and for the rules of health for man and domestic animals such are matters which should first be taught to everyone who is to live by tilling the soil; and this can be done only by the experimental method."

As a higher stage in Agricultural education it is proposed to maintain agricultural schools the first at St. Vincent, St. Lucia, Dominica and St. Kitts. The boys will be fed, clothed and trained free. Admission to these schools will be offered as an exhibition to boys in elementary schools of about 14 years of age who have passed the IV Standard and who show moral and intellectual aptitude for such instruction.

We have next the scheme of instruction in Agriculture to boys in Secondary and High Schools assisted by the special lecturers in Agriculture provided by the Imperial Department. At the same schools scholarships are offered to boys from the

country districts, the sons of planters in moderate circumstances, who intend to devote themselves to agricultural pursuits.

Lastly, there are lectures to the younger generation of planters and others engaged in Agricultural pursuits to afford information and assistance in elucidating the scientific problems which underlie the practical work in which they are daily engaged.

This is a brief sketch only of the scheme of Agricultural Education now being actively carried on in these Colonies. The details have been carefully and gradually evolved in conjunction with thoughtful and leading men with great educational experience, and it may be confidently anticipated that if efforts are consistently sustained for a generation at least, we shall lay the foundations of a larger measure of prosperity for all classes of people in these Colonies, both white and black, than has been possible in any previous portion of their history.

TREATMENT OF DISEASED PLANTS.

At the last Conference, following a paper read by Mr. W. Fawcett, F.L.S., on the prevention of the introduction and spread of fungoid and insect pests, it was very forcibly impressed upon us that some general effort was necessary to be taken in the West Indies to protect our crops from the destructive influences of pests. Action under this head would naturally divide itself into two categories: (1) the effective treatment of pests already existing, thus eradicating or checking their spread amongst economic plants; (2) the adoption of such measures as may be found suitable and convenient to prevent the introduction of other pests into the West Indies.

In regard to the first, I may mention that the Secretary of State has approved of the appointment of an Economic Entomologist on the staff of the Imperial Department of Agriculture. The officer selected for the post Mr. H. Maxwell-Lefroy, B.A. of King's College, Cambridge, has already arrived and taken up his duties. His services will be available to the West Indies generally and he will travel as required. In the case of Jamaica and British Guiana, where the Curators of the Museums in those Colonies have already given valuable assistance in this direction, both to the Government and the general public, it is anticipated that Mr. Lefroy's collaboration will not be necessary. This will allow him more time to devote to problems connected with the other Colonies where, I fear, the destruction of food and other crops has reached a stage that will require the utmost energy and skill to deal with it. The injury done by scale-insects (Coccids) amongst citrus fruit (limes, oranges, grape-fruit &c.) has in some cases led to the total abandonment of cultivation. After a careful study of the life-history and the identification of these pests steps will be taken to deal with them by "spraying" and what is known as the "gas treatment," so as to reduce their number and operations within such limits as will enable cultivation to be carried on without serious loss. Scale-insects

also attack cocoa-nut palms, and almost every economic plant in the West Indies.

Specimens of insects causing injury to plants and intended to be reported upon by the Imperial Department of Agriculture should, in the first instance, be sent to the Commissioner through the chief botanical officer in the Colony, accompanied by full details and securely packed for transmission by post. With regard to the second of the steps necessary to be taken, viz: to adopt measures to prevent the further introduction of pests into the West Indies it would be well to extend action under this head to both fungoid and insect pests. Last year it was suggested by Mr. Fawcett that the machinery necessary for this purpose would be an Act entrusting general powers to the Governor of every West Indian Colony to prohibit, under competent advice, the importation of seeds, cuttings or plants, wrapping &c, likely to lead to the introduction of any specific insect or fungoid pest, from any country where it was known to exist. Outside this it is desirable also to provide for the inspection at the port of entry of all cuttings and plants so as to keep the circulation of these strictly under observation and deal with them in the general welfare of the Colony. The subject is down for discussion on Monday. In the meantime copy of correspondence bearing upon it has been printed and will be distributed amongst the Members of the Conference.

I only add that I look forward with great interest to the business of this Conference and I am confident you will all heartily join me in rendering it productive of good to all parts of the West Indies.

Professor J. P. d'Albuquerque then rose and moved a vote of thanks to the President for his very able and interesting inaugural Address.

The Honourable Francis Watts seconded the motion which was carried unanimously.

The following papers were read at the Conference :

SUGAR INDUSTRY.

Notes on Sugar Cane Experiments. (Professor Harrison and Mr. G. S. Jenman.)

The lines of future work in sugar cane Manurial Experiments. (Professor d'Albuquerque.)

Possibility of improving the Sugar Cane—

(*a*) by artificial cross fertilisation,

(*b*) by chemical selection of "seed cane"

(Professor d'Albuquerque)

A method of using control plots in experimental field cultivation. (Professor d'Albuquerque.)

Rotation and Catch Crops on Sugar Estates.
(Mr. J. R. Bovell)

Green manuring as a means of fertilising cane-lands in the West Indies. Illustrated with specimens of plants, seeds, tubercles, &c. (Mr J. R. Bovell)

Silos on Sugar Estates in Barbados.
(Mr. E. E. H. Thorne, F. I. C.)

The present position of efforts to supply "Central Factories" at Barbados and Antigua. (The Hon'ble. F. J. Clarke and the Hon'ble Francis Watts)

EDUCATIONAL.

Teaching Agriculture in High Schools and Colleges.
(Mr. H. Deighton and the Revd. W. Caroll)

Teaching Agriculture in Elementary Schools. (The Revd. J. E. Reece, Colonel Hicks, Mr. Wm. Blair, Mr. Collens, Mr. Watkins, and Mr. Hudson.)

School Plots as aids in teaching Agriculture in Elementary Schools. (Hon. W. Fawcett.)

Aims and Objects of Experiment & Teaching Stations.
(Rev. Canon Simms.)

Experiment Station Work in Trinidad. (Mr. J. H. Hart)

GENERAL.

Food Supplies of the Leeward Islands. (Hon. Francis Watts)

Distribution of Economic Plants in relation to Agricultural development (Hon. Wm. Fawcett)

Steps taken at the St. Vincent Botanic Station for the distribution of seeds, plants etc. after the hurricane of 1898. (Mr. Powell)

Suggestions for increasing the usefulness of the Botanic Stations. (Dr. Alford Nicholls.)

Packing seeds and plants. (Mr. J. H. Hart)

Bee-keeping in Jamaica. (Mr. T. R. Doidge)

Suggestions for the inspection and treatment of imported plants (Discussion)

NOTES ON SUGAR CANE EXPERIMENTS *

BY PROFESSOR J. B. HARRISON, M.A., F.I.C., F.G.S., F.C.S.,
Government Analyst, and
GEORGE S. JENMAN, F.L.S., Government Botanist and Superintendent of the Botanic Gardens, British Guiana.

In response to a request from the President, we have prepared for this Conference a paper dealing with future lines of experimental work with the Sugar Cane in the West Indies. Unfortunately the Conference is being held just at the end of the busiest season of the year in British Guiana, and that coming together with the very great amount of routine official duties which falls to the share of both of us far in excess, both in amount and variety, of those devolving on the officers holding similar posts in the British West Indian Islands, has prevented us doing more than throwing together a few rough notes.

MANURES.

We will first of all deal with the subject of the manures requisite for the sugar cane. Possibly, some here will consider that the mode of preparing the land ought to have received consideration before manures, but as these modes must necessarily vary in each colony or island, and to a great extent even in the different districts of each of them, we do not think that any useful purpose is likely to be attained by our describing and criticising the methods adopted in the few islands and colonies we are personally acquainted with.

Fifteen years ago the subject of the manuring of the sugar cane was one which could be approached with a light heart. So little was known that the writer of a paper could safely assume that he could not know less than those to whom it was read: but now the matter is on a different footing, every planter and some chemists and botanists consider themselves authorities upon it, although their opinions are far too frequently based on deductions drawn from their later experiences, those of former years to which at the time they tenaciously held being conveniently forgotten. It is now twenty five years since one of us first arrived in the West Indies whilst the other has nearly attained the legal majority in the years of his residence. At the time when we came out here, the majority of planters chose their manures by the smell, the colour, the name of the maker and the size of his advertisements, but principally by the amount of credit the seller allowed. The longer the note could run, (and we believe that some are still running) the better the manure. Is it to be wondered at that in those days the planter cheerfully applied Glauber's salts, Epsom salts or common salt sold to him for use as nitrogenous manures, or sought refuge and, as he hoped, safety, in the application of

* NOTE:—In justice to the writers of these Notes it is desirable that our readers should bear in mind the pressure of circumstances under which they were prepared. It is hoped in future notes on the same subject, several points now only briefly referred to will be dealt with in detail.— ED. W.I.B.]

natural manures such as Peruvian guano, at times consisting principally of rocks, or of advertised nostrums such as the Urban sugar cane manures, the sole virtue of which lay in the fee paid to the chemists who puffed them?

But now planters have gone to the other extreme, and we doubt whether in many cases they do not injure their soils and the yields of their crops by the application of their ill-digested study of the conflicting results offered for their guidance by various experiment stations. It is an open question as to whether the makers of certain manures in by-gone times did not merit the gratitude of their customers by preventing over-manuring with active constituents.

At the present time, planters are becoming more and more unwilling to be guided by the large and varied experience of such respectable makers of manures as Messrs. H. E. Thorne & Son of Barbados, the Anglo-Continental Manure Co., the Lawes Manure Co., and Messrs. Packard & Sons, not to mention a host of other manure producers. These makers have their chemists, usually men of high attainments, and, as a rule, are in far better positions of judging the requirements of various plants on varying soils than are the so-called practical planters and, dare we hint it, in some cases the officers in charge of experiment stations. Guided to some extent by the local knowledge of the few official chemists of the West Indian Colonies, of whom one of us is now the sole survivor of those who held office in the early eighties, the reputable manufacturers trusting to their own resources prepared the manures which produced the large crops which characterised the later years of the eighties, and one or two of the first of the nineties. The only points that can be advanced against the use of the special manures of reputable makers is that they may contain ingredients which may not be essential to the soils upon which they are to be used, and that the makers reap a well earned profit from the use of their knowledge and reputation.

As, however, the sugar planter is at present determined to know as much of the science of agricultural practice as he can, and especially as in some of the islands and colonies, of which there are representatives here to-day, the item of manure bulks large on the year's accounts, and, not infrequently, materially diminishes the net profits for the proprietors, we will consider the various points by attention to which possibilities of improved yields at decreased costs are, in our opinion, promised. We will deal with our subject under the following heads:—

1. Nitrogenous manures; 2. Phosphatic manures; 3. Potassic manures; 4. Calcareous manures; 5. Complete manures; 6. Pen manures.

NITROGENOUS MANURES.

All, with the possible exception of the Leeward Islands Chemist, are now well satisfied that, if all other essential constituents of plant food are present and the climatic conditions favourable, the field yield of the sugar cane is governed by the amount of available nitrogen which is at its disposal. This is

amply proved by the results of experiments in British Guiana, in Barbados, in Louisiana, in Java, in the Mauritius, in Hawaii, and in Queensland. The points which require local examination by the experimental stations are in our opinion the selection of the most suitable and economical form by which the nitrogen can be applied, and the determination of the amount which the plant can make full use of.

The most available forms for use in the tropics are doubtless sulphate of ammonia and nitrate of soda. The former appears to generally result in the more favourable returns, and is easier of application and cheaper of carriage (per unit of nitrogen.) In British Guiana, we certainly give the preference to the ammonia salt and there are no signs of the abatement of such preference. We admit that, if carefully and intelligently applied in comparatively small dressings, nitrate of soda will give at least as good results as an equivalent amount of sulphate of ammonia: its great liability to deliquescence in our damp climate and its liability to loss by surface drainage, caused by heavy rains soon after its application, being its main drawbacks. Experiments have shown us that as a rule 250 lbs. of sulphate of ammonia per acre, an amount yielding about 50 lbs. of nitrogen, is the most certainly profitable dressing, and when used at this rate we may safely calculate that each 10 lbs. of nitrogen per acre applied in the manure will result in an average annual yield of two tons of canes over a series of years, and may result in one of two and a half to three tons in favourable years and on well tilled soils.

When sulphate of ammonia is applied in quantities greater than 300 lbs. per acre, the question arises as to whether any commensurate advantage is likely to be obtained. Up to the present, experiments have shown that such advantage is problematical, and dependent on the climatic conditions. In unfavourable years no commensurate advantage has been gained, but a pecuniary loss sustained. In average years the additional yield has recompensed us for the cost of the manure, while in good and favourable years considerable profits have been obtained.

With nitrate of soda, similar results have been obtained only with dressings not exceeding 250 lbs., equal to 40 lbs. of nitrogen per acre; but with heavier dressings no commensurate advantages have been obtained in either unfavourable, average, or favourable years.

As far as our experiments have been carried, nitrogen in organic matters, such as dried blood, have always given lower yields than have equivalent amounts in the form of sulphate of ammonia and nitrate of soda.

We have, however, got the best results by using mixtures of nitrate of soda and of sulphate of ammonia in the proportions of one third of the nitrate to two thirds of the sulphate.

These results have been obtained on more or less heavy clay soils and it appears to us that others materially different may be obtained on lighter lands. Also, as it is important in Demerara for the canes to have an active growth during the

earlier months of their career, and, that such active growth should terminate in time for them to be able to mature before the reaping season, we have always applied the whole of the nitrogen either as sulphate of ammonia, nitrate of soda, or dried blood, at an early period and in one dressing.

The points which in our opinion require investigation with regard to nitrogen are to ascertain the maximum amount which can be economically applied in average years, and to determine the advantages or disadvantages of the manuring being done in one or more applications.

This must be the work of the local stations, the larger ones being more fittingly occupied by investigating the broader principles of scientific agriculture.

It would also be desirable for comparative experiments to be made with such substances as dried blood, and with other organic sources of nitrogen on both light and heavy soils.

PHOSPHATIC MANURES.

We have next to consider the application of phosphoric acid. It may be taken as an axiom in sugar cane planting that phosphates must be applied to the soil if the healthy growth and vigour of the plants are to be maintained. The forms which have been recommended are used as finely ground mineral phosphate of lime, precipitated phosphates, bone flour, superphosphate of lime, finely ground Redonda or Connétable phosphates and slag phosphates.* Experiments have proved that the action of finely ground mineral phosphates is very slight: and that while the action of precipitated phosphates is marked, their cost prohibits their use. In all cases, the use of finely ground bone phosphates has given fair returns, but at a high cost compared with several other forms.

Where superphosphate of lime is used, it is necessary for it to be applied cautiously, as in several cases its use in very high proportions has not resulted in increased yields. Carefully conducted experiments are necessary to find out the cause of this, whether it is due simply to excessive acidity, or to acidity in the form of sulphuric acid or whether, as the Commissioner of Agriculture suggested at the last Conference, to some physiological action. Although we noticed this action many years ago with ordinary superphosphate in Barbados, we have not noticed it in Demerara; on the other hand, there, increased dressings have given increased yields, and one year when a portion of the field by an error was dressed with concentrated superphosphate with 13 per cent. assimilable phosphoric acid instead of the ordinary with 16 per cent., the results were markedly in favour of the heavier application. But in Demerara the most suitable form of phosphoric acid for application to plant canes is that in finely ground slag phosphate, and we are inclined to think that this will frequently prove to be the case elsewhere. We are strongly of opinion that experiments should

* NOTE:—Redonda is a small rocky islet off Montserrat in the Leeward Islands. Connétable lies off the coast of Cayenne or French Guiana. Both islets are a source of the phosphatic manures named after them.—[ED. W.I.B.]

be directed towards the possibility of the economical substitution of slag phosphates for superphosphate on different soils. A comparative series of experiments made with finely ground Redonda or Connétable phosphate would be of great interest as tending to elucidate the problem as to how far the lime in the tetrabasic phosphate, present in slag phosphates, affects the returns.

We have not noticed any very marked effect from directly manuring ratoons with superphosphates, or with slag phosphates, and we are very doubtful if it is worth while doing so. To ascertain this is an object well worthy of investigation.

Our experience indicates that on the heavy clay soils, and on the pegass lands of British Guiana, a heavy dressing of five or six hundred weight per acre of slag phosphate, applied to the plant canes, is the most profitable mode of applying phosphoric acid.

POTASSIC MANURES.

While nitrogen is emphatically the constituent which governs the yield of the cane, and phosphoric acid is in almost all cases a necessary addition if it is desired to have a succession of full and healthy crops, potash is, as a rule, a constituent of minor importance. In Barbados on many soils the proportion of potash, probably never high, has by constant cropping with canes, sweet potatoes, maize, and leguminous crops been so reduced that its application is now necessary for the successful raising of crops. This is especially the case in the soils derived from the Oceanic series, but there are clay soils in the Scotland districts derived from the Oligocene deposits which are rich in available potash. In Demerara the application of potash to plant canes has little, if any, effect, due doubtless to the large proportions of available potash in the soils of our heavy clay coast lands.

The need of the soil for potash must be tried at each experiment station, as although in many cases originally present in fair proportion, it is the soil constituent (other than nitrogen) the immediately available supply of which is the first in very many cases to fail through repeated cropping.

We remember that, some years ago, one of us was criticised in one of the Barbados periodicals and interested motives assigned to him, merely because he did not hold the extreme opinions about the great amount of potash necessary for the Barbados soil which had been credited to him. We recognise the importance of a readily available supply of potash in the cane manures for the majority of the island soils of the West Indies, but we do not recommend, nor have we ever recommended, attempts to supply all the potash necessary for the crops in manures, and we especially deprecate the substitution of large quantities of potash salts for the phosphoric acid of the manure. Our view is that a supply of readily available potash in the manures is of importance to the young plant during the time while its root development is insufficient for it to avail itself of the supplies in the soil, and we hold that the role of the added potash is to enable the plant to attain rapidly

a development sufficient to allow it to make use of the stores in the soil. This brings us to a point which deserves investigation: the application of potash salts and possibly of phosphoric acid in a readily diffusible form to ratoon canes just as they are springing. We are inclined to believe that on soils even where not deficient in potash the addition of light dressing of these as manures to ratoon canes, just as they commence to throw up new shoots and to start a fresh root development, will be very beneficial. For this purpose, experiments should be made, using, as sources of potash, the phosphate and the nitrate, other conditions such as the use of nitrate of soda on control plots being observed so as to enable the effects of the nitrogen and of the phosphate to be eliminated from the observed results. It is a difficult matter to get manures uniformly spread through the soil with ratoons, and, hence, we recommend the trial of salts of relatively high availability.

CALCAREOUS MANURES.

This is a class of manures to which we are of opinion not sufficient attention has as yet been given in the West Indian Islands. Because a soil rests on limestone, it is not correct to assume that it contains a sufficiency of lime, as in many cases, such soils are very deficient in available lime. In Demerara, our heavy clay soils are as a rule very deficient in available lime, and its application may be productive of much good. For instance, on our experimental field an application of five tons of slaked lime per acre was made in 1891, and the average weight of canes gained in six crops has been in round numbers 27·5 tons —that is, the lime has enabled us in six crops to get the equivalent of seven. Its action is not yet over, for this year, when the continued drought has prevented us reaping the plots, we have found that the canes from the limed parts on an average weigh ·25 of a lb. more each than those from the not limed, which would be equivalent to an excess yield due to the lime of over a ton and a half to the acre. Such increases as these shew that it is well worth while for us to experiment on the effects of lime on other West Indian soils, where, although it is not likely that so great increases will be obtained as the physical action will not be so great as it is on our heavy, badly-drained, clay soil, there are many reasons for expecting good to result.

COMPLETE MANURES.

Our experience has shown that the nitrogen in complex thoroughly mixed manures apparently is about ten per cent. more effective than it is in the more roughly prepared home made mixtures; and we consider that on old soils like those of some of the islands, considerable advantage will be gained by the use of them instead of home made mixtures. As a complex manure for use on old soils, we consider that Peruvian guano is the best, and one of us has not abated his opinion in the slightest as to the advantages which genuine dissolved Peruvian guano has over other mixed manures. On new or relatively new soils, such as our Demerara ones, the complex manures are of less value over the simpler compounds.

It has frequently struck one of us that our attention may have been unduly drawn away from certain minor soil constituents which may be present in minute quantities, by the importance of nitrogen, phosphoric acid, and potash, and that, perhaps, the steady falling off which at times occurs in the agricultural return and which does not yield to the application of the usual constituents of manures may be due to the temporary exhaustion of some soil constituents present in minute quantity, and whose importance, we, in our haste to be scientific, have overlooked. We therefore suggest that the complex manures supplied by makers should have a place in the manurial schemes of the Department, especially guano both raw and dissolved.

PEN MANURES.

By some considered an unavoidable evil, by others an unmixed blessing for which no expense is too great to be incurred pen manure, as made in the West Indian Islands on field pens, has little claim to the title of manure, but it still has its value for the purpose of adding humus to the soil, and thus increasing the retentive power of the soil for water. Probably also the field pens are useful as nurseries for the supply of the useful bacteria to the soil. But we must consider as to whether the great cost of building these compost heaps and of spreading them on the land does not far outweigh the advantage obtained. We are of opinion that the field pen is a mistake, as the small quantities of manurial ingredients contained in the litter and fodder of the cattle, are largely lost by drainage, the patches of land immediately under and in the neighbourhood of the pen alone gaining. The pen manure should be made under cover, and as little litter used as possible, the amount of earth added being only sufficient to absorb the moisture of the urine and faeces so as to give the animals a dry footing. That is, no expenditure that can be avoided should be incurred simply with the idea of making pen manure: it should be regarded as a by product and not as one of the main objects of the planter. In other words instead of appearing in your books as manure, it should form an item to be credited against the cost of carriage and of tillage. The manure thus obtained would be richer although not so bulky and weighty as is the present compost, and it could be more cheaply applied and be more effective.

Our experience in Demerara has not led us to attach a high value to pen manure or even to stable manure as manure *per se*. Twenty tons of pen or stable manure, costing say thirty dollars have practically the same cane producing power as two hundred weight of sulphate of ammonia which costs about six dollars. On our clay soils, the application of farmyard manure has but little after effect and with us the cane tops are returned to the soil directly.

But in the soils of the islands which frequently are of low retentive power for moisture, pen manure has doubtless a high value especially as adding organic matters to the soil. Our tropical soils are, as a rule, not rich in humus, and are of low

retentive power for moisture, and the proportion of humus originally present has been very rapidly reduced by tillage. The organic matter can be added to the soil by the use of snatch crops, and for this purpose crops which either assimilate nitrogen from the air or which use up the supplies stored in the subsoil are most suitable. Whether equally good results will be obtained by at once ploughing in the green crops, or by making them into compost, can only be settled by experimental trial; in our opinion, higher returns will probably be obtained by composting them, but it is doubtful if the practice will repay the additional expense. If this practice of growing leguminous dressings is adopted, it will be advisable to manure the soil for their growth with dressings of potash and phosphoric acid, so as to enable them to attain their fullest development.

An important point with regard to manures for the sugar cane in the West Indian Colonies is their application for the purposes of ameliorating the effects of droughts.

The early application of suitable manures to the sugar cane, after the termination of a period of drought, may greatly mitigate its evil effects. The manure must be composed of readily diffusible and available constituents. We believe that a dressing from one hundred weight to one and a half hundred weights of nitrate of soda mixed with from half to three quarters of a hundred weight of phosphate of potash per acre of canes, applied as soon as possible after the cessation of a prolonged drought, will amply repay its cost.

It may be of interest to some of the planters of Barbados to learn our opinion as to the most suitable manuring for a series of cane crops. We recommend that, before planting the canes, the land should be liberally manured either with manure from well fed animals prepared under sheds, or with green dressings recently dug in. If the pen manure or the green dressings are insufficient in quantity, early cane manure with about 1 per cent. of nitrogen, 10 per cent. of available phosphoric acid and from five to seven per cent. of potash should be used in quantities of two or three cwts. per acre. For June application, if the early cane manure has been used, 4 cwts. (if not 5 cwts.), of dissolved Peruvian guano or similar manure, containing from 7 to 8 per cent. of nitrogen and 10 to 11 per cent. of assimilable phosphoric acid with from 2 to 4 per cent. of potash, will be a suitable application. As soon as your ratoons spring, a light dressing of one to one and a half cwts. of nitrate of soda per acre is advisable which should be followed by the use of four or five cwts. of a manure containing eight to nine per cent. of nitrogen, from seven to nine per cent. of available phosphoric acid, and from four to six per cent. of potash. On a soil rich in potash, a mixture of two thirds dissolved guano and one third sulphate of ammonia is very suitable: on other soils, a mixture of two thirds early cane manure and one third sulphate of ammonia will be a cheap and effective application. For second ratoons, a similar light first dressing of nitrate of soda is advisable, while the succeeding manuring should be more nitrogenous than that of the first ratoons, say

half dissolved guano and half sulphate of ammonia, or half early cane manure and half sulphate of ammonia. For third ratoons, the limit in our opinion to which it is advisable ever to attempt to carry on cane cultivation, the early application of nitrates should be given, while the later dressings should consist wholly of say 2 cwts. of sulphate of ammonia or 2½ cwts. of nitrate of soda, or of 1 of the former and 1½ of the latter. We believe that such manuring would be economical and past experience has proved that it has been effective provided that the seasons are favourable.

We shall follow with great interest any experiments to improve this scheme, especially in the direction of the use of slag phosphates and sulphate of potash to the cane plants in the place of the mixed manures, using two, to two and a half cwts. of sulphate of ammonia as the nitrogenous constituent for the later dressing; and of the addition of phosphate of potash to the first dressing for the ratoons.

To recapitulate, our opinion is that with regard to purely manurial matters, the following points require attention on the part of the experiment stations:

1. Comparison between sulphate of ammonia, nitrate of soda, and organic substances, as sources of nitrogen on different soils and under different climatic conditions.

2. To ascertain the maximum amount of nitrogen which can be applied in average seasons with the expectation of paying returns.

3. To test the relative advantages of applying the nitrogenous manures in one or more dressings.

4. To test the relative advantage of applying the nitrogen in one form or in a combination of two or more forms.

5. To compare the relative value of slag phosphates and of superphosphates.

6. To compare the action of phosphates upon plant canes and upon ratoons.

7. To test the necessity for potassic manuring upon different soils.

8. To examine into the effects of the addition of potash and of phosphate in a diffusible and readily available form to ratoons at the commencement of their growth.

9. To examine into the action of lime both in light and heavy dressings on soils of different composition and texture.

10. To compare the relative action and value of the nitrogen in complete manures, such as raw and dissolved guano, and of that on manures mixed on the estate.

11. To compare the relative values of nitrogen as applied in pen manures and in artificial.

12. To compare the value of composts with green dressings ploughed directly in.

13. To compare the value of different forms of leguminous

plants as green dressings, and their effects with those of pen manure.

14. To compare the yield of green dressings when raised with, or without, the application of mineral manures.

15. To compare the pecuniary results of the cultivation of leguminous plants for manurial purposes, and of raising snatch crops for feeding the people.

EXPERIMENTS WITH LONG KNOWN VARIETIES OF CANE.

We are of opinion that these are no longer necessary, except with a few varieties such as the purple and white transparent and the red and green ribbon canes.

EXPERIMENTS WITH SEEDLING CANES.

This is probably the most promising line of experimentation to be carried on. It is important to ascertain from which of the older varieties the most promising seedlings are obtainable, and to use them as parents. Unfortunately the ease with which fertile seed is produced by many of the new varieties is so great compared with that of the more valuable of the older varieties that it appeals to us; therefore much more attention is being given to raising seedlings from new varieties than from the older canes. Our belief is that valuable varieties are more likely to be obtained from the striped kinds than from others, the striped ones showing a remarkable range of variation among their offspring. So much has been written and said about seedling canes and their selection in accordance with certain characters that it is not necessary for us to add anything more.

A point of great importance is that the characters of the more promising varieties should be ascertained by rigorous experiments. Up to the present few, if any, experiments have been made using control plots in a similar manner to their use in manure experiments.

The demand of the new varieties for nitrogenous manuring will differ widely, and each promising variety should be subjected to experiment so as to ascertain the relative amounts of nitrogen they can make use of, and the desirability of applying the nitrogen in one dressing early or in a series of applications. This depends upon the remarkable variation in their period of growth, some coming to maturity in eight or nine months, others requiring double that length of time. And this difference must be taken into account when reaping them. Recently we noticed an account of an experiment where a cane normally of very high saccharine strength and coming to maturity in from eight to ten months was allowed to remain on the land for we think seventeen months and wonder was expressed that its juice was not rich.

In our opinion too much stress is being laid by some writers on the advantage of canes having a short period of growth; we believe that weight of cane per acre and consequent weight of sugar will only certainly and regularly be

obtained by canes having a relatively long term of vigorous growth. We have very grave doubts if on the large scale the exceptionally sweet but small cane of short growth will hold its own against canes of medium to fairly high saccharine strength of longer period of growth. The latter, as far as our experience goes, are the more promising.

OTHER EXPERIMENTS.

Many methods have been suggested for improving the cane, in which we have but little faith. Among these may be mentioned the somewhat rare phenomena of bud variation, cross fertilisation (if it be feasible), selection by chemical analysis and grafting. All these require actual trial in order to prove or disprove their feasibility and possible advantages. Up to the present, the results reported cannot be said to show much promise in any of these lines. Their preliminary investigation is essentially the work of the larger stations which are directly controlled by skilled botanists and horticulturists.

CANE DISEASES.

The attention of all agriculturists, as well as of the scientific workers with the sugar cane, must be steadfastly directed to these matters, and a knowledge of the life-history of the animal and vegetable parasites will doubtless greatly aid in their eradication. To our mind the most striking result, so far, with regard to investigations in Java and elsewhere into cane diseases and their causes is, that we appear to have all the known diseases among our canes and are to some extent relieved of the dread of immediate attacks of others which we have not yet experienced. And equally of importance with the study of the nature of the diseases of the cane, is that of the causes which settle whether an organism, usually saprophytic, shall or shall not become parasitic. We consider that this may largely depend on slight chemical changes taking place in the juices of the plants, a matter which is receiving the attention of certain highly-skilled observers.

DRAWING UP REPORTS AND STATEMENTS OF RESULTS.

Of importance only less to the securing of accurate and reliable results is the mode of their communication to the planters. We are strongly of opinion that Station reports should include a record of all experiments of any importance being carried on, and that they should give the matured opinion formed after mutual discussion of the results, by both the Botanist and Chemist in charge of the Station.

The form of tables to be used is of some importance, and should be settled at one of these Conferences. Some, we have recently seen, contain no information whatever about the weight of the cane, an omission which, in the case of varieties of canes either old or new, must materially militate against the value of the report. It is of no practical interest to the sugar-world to report the occurrence of canes of high saccharine strength if

these canes are too small or in other respects unsuited for the purposes of the planter.

We are of opinion that the following items should appear in the reports of the first year's growth of seedling varieties: -

1. Name of parent cane and number of seedling.
2. Colour.
3. Average length of cane.
4. Average weight of cane.
5. Per cent. of juice extracted by mill.
6. Specific gravity of juice.
6. (a), Degree Brix.
7. Pounds per gallon of juice saccharose.
8. „ „ „ „ „ glucose.
9. „ „ „ „ „ solids not sugar.
10. Quotient of purity of juice.
11. „ „ impurity or of non-sugars.
12. Glucose ratio (as a guide to condition of cane when reaped.)

In addition to these, information may be registered regarding the girth, number of joints and their size."

In reports of later years' growth of seedling canes and of the older varieties the following may be desirable heads: -

1. Number or name of seedling.
2. Colour.
3. Number of stools.
3. (a), Number of canes per stool.
4. Weight of canes per acre, tons.
4. (*a*), Weight of cane tops per acre, tons.
5. Average weight of one cane, pounds.
6. Average weight of one stool of canes, pounds.
7. Per cent. of diseased, rotten or rum canes.
8. Per cent. of juice extracted by mill.
9. Specific gravity.
9. (*a*), Degree Brix.
10. Gallons of juice per acre.
11. Pounds per gallon of juice, saccharose.
12. „ „ „ „ glucose.
13. „ „ „ „ solids not sugar.
14. Quotient of purity.
15. Quotient of non-sugars or impurity.
16. Glucose ratio.
17. Pounds of saccharose per acre.
18. Value of yield compared with that of a standard variety, grown on the same soil and during the same season or seasons, taken as 100.

A possibly useful addition for enabling those colonies and countries which do not read their results in pounds

per gallon, is to show the percentage composition of the juice

In reports of manurial experiments the following headings may be useful :—

1. Number of plots.
2. Manuring of plots.
3. Cost of manures.
4. Produce, tons.
5. Cane tops, tons.
6. Canes, tons.
7. Per cent. of diseased, rotten or rum canes.
8. Juice per cent. expressed by mill.
9. Specific gravity of juice.
9. (*a*), Degree Brix.
10. Gallons of juice per acre.
11. Pounds per gallon saccharose.
12. " " " glucose.
13. " " " solids not sugar.
14. Quotient of purity.
15. " " impurity or non-sugars.
16. Glucose ratio.
17. Composition of the juice, water.
18. " " " saccharose.
19. " " " glucose.
20. " " " organic non-sugars.
21. " " " ash.
22. Pounds of sugar per acre.
23. Equivalent yield of 1st & 2nd sugars in tons, per acre.
24. Gain in produce per acre by manuring.
24. (*a*), Gain in canes " " "
25. Gain of produce on unmanured plots taken as 100.
25. (*a*), Gain of canes " " " " " 100.
26. Profit by manuring.

If in addition to the above, the number of canes per acre and per stool, and the weights per stool and per cane are registered, information may be obtained of considerable value in determining the action of the manures. But it is a matter of considerable difficulty to obtain this information where canes are planted in rows.

Probably the other officers connected with Experiment stations present, may be able to offer valuable suggestions with regard to the above statements of results either by additions to, or preferably by emendations from the heads we have mentioned.

We fully recognise the hurried and imperfect nature of the foregoing notes for which we have already offered our apologies, but we have brought them forward in the hope that some of the points which have struck us during our long experience may be useful to some of the members of the Conference and suggestive of future lines of research on the

stations established by the Imperial Department of Agriculture for the West Indies.

The PRESIDENT: We are very much obliged for the very able paper which has been presented to us by Professor Harrison and Mr. Jenman. This paper will shortly be published in the *West Indian Bulletin*, and we shall be able to read and carefully consider the many interesting points presented to us. Before proceeding to a discussion it would be convenient if Professor d'Albuquerque were to deal with the points raised in his paper covering somewhat similar ground.

NOTES ON THE PRESENT AND FUTURE LINES OF MANURIAL EXPERIMENTS IN BARBADOS.

BY PROFESSOR J. P. d'ALBUQUERQUE, M.A., F.I.C., F.C.S.,

Island Professor of Chemistry in Chemical charge of Sugar Cane Experiments.

For 14 years annual reports have been issued upon the results of manurial experiments at Dodd's Botanic Station in this island, and since the inauguration of those experiments, others have been carried out at Antigua, and a very comprehensive series in British Guiana. Owing to considerable differences in soil and climate, the results obtained at one station cannot be applied in their entirety or directly to another colony, but there are doubtless certain results which are more or less generally applicable, while others chiefly apply to the colony where those results were obtained; and it would be of great interest if the Chemists who are met together to-day could come to some conclusion as to what we may take as settled and generally applicable in the results that have already been worked out, in order that we may discuss the lines which future work ought to take.

In the following brief remarks, I confine myself to the conditions existing in Barbados, and I leave the matter of other colonies to be discussed by the Chemists connected with them.

Among the substances known by analysis to be taken up by the cane plant from the soil, the first question is: What are those which the soil does not contain to a sufficient extent to supply the most advantageous amount, in a form available to the plant? Every Chemist present who is acquainted with Barbados soils will agree that nitrogen, potash, carbonate of lime, phosphates and sulphates are the substances which should primarily attract our attention.

Taking these substances, one by one, I shall very briefly consider some of the sources from which they may be profitably derived, and, where experiments have been tried, the results of them; and indicate what in my opinion are some of the questions, in respect to each constituent, remaining to be answered.

It is now generally admitted by all workers that of all the manurial constituents that affect the profitable growth of the sugar cane, nitrogen stands out as at once the most important as well as the most expensive, and experiment has pretty clearly established that it can be profitably applied in such active forms as sulphate of ammonia, nitrate of soda, or guano nitrogen compounds to the extent in Barbados of 40 lbs. to 80 lbs. per acre during a crop, the amount depending upon the soil, upon whether we are dealing with plants or ratoons, and the amount and distribution of rainfall: the larger amount giving the best results when the rainfall is large and well distributed; that sulphate of ammonia, if the only form applied, may have advantages over nitrate of soda, the effects of the latter form, as would *a priori* be expected, being more rapidly apparent, that of the former being spread over a longer time; and that probably the best active nitrogenous application is a mixture of the two. In the most recent Barbados manurial experiments I have used a nitrogenous application consisting of $\frac{2}{3}$ sulphate of ammonia and $\frac{1}{3}$ nitrate of soda, and while a very small amount of nitrogen may, perhaps, be applied with advantage shortly after the cane germinates, it is best to apply the larger portion in June to August, at and after the beginning of the most active period of the cane growth; and one of the applications should proportionately be a fairly large one with a view to encourage tillering. There is a fair amount of evidence to support the above conclusions, but they require confirmation for the typical soils of this island; and I think that our immediate experiments should aim at settling whether the above is correct, at ascertaining the modifications desirable with different soils, the relation of the amounts to the rainfall, and what must be the relation between the price of nitrogen and sugar to render a given application more profitable than any other.

Two of the forms of nitrogen-suppliers which deserve careful consideration are farmyard manure and leguminous green dressings. At the Conference last year Mr. Bovell's estimate of the cost of growing a ton of canes in Barbados was received with a good deal of surprise and gave rise to considerable discussion: but subsequent enquiries have confirmed the correctness of that estimate, and have shewn that whatever may be the possibilities of cheapening, in the past the price has been substantially what was stated by Mr. Bovell. In looking through the details of the estimates to try and discover to what is due this high cost, one, but not the only expensive item that strikes us, is the cost of farmyard manure; and that to lessen the expenditure on this item is a most important desideratum.* Another circumstance directing our attention to that form of manure is the hope that at no distant date we may be working our canes in Central Factories, a system of manufacture which with its network of rail lines will great-

ly diminish the number of cattle necessary to work the estates. The experience of planters in our long-worked land points to the necessity for a liberal supply of organic matter in some form, and admitting that necessity, unless with the advent of Central Factories we are content to see our field returns fall off, we shall either have to keep more stock than we want, or look for some substitute for farmyard manure, and its costly nature leads us to look for a cheaper substitute. Without going into unnecessary detail, I am of opinion that our subsequent researches in Barbados will have to take up the question of how far the organic matter in our pen manure can be replaced by that of green dressings, how far the nitrogen of our pen manure and chemical manures can be replaced by that stored up in leguminous green dressings, how far the making up of our pen manure can be cheapened by less moulding and carting, and the kindred question of the treatment of trash in the cane fields, whether it would not be equally efficacious and more economical to bury it *in situ* instead of carting it to the pens, and whether trash buried just beneath the surface around young cane plants will not give better results than spread on the surface,—as the 1896 Mauritius results shew even in a year of drought. These questions of organic nitrogen supply should form a part of our field experiments as well as a subject for careful laboratory analyses.

While probably every Chemist here to-day will agree as to the necessity of applying nitrogen in an active form to every field of canes, whether in Barbados or Demerara, there would probably be less unanimity on the subject of the mineral constituents that should be applied: and here much more than in the case of nitrogen, much will depend upon the nature of the soil.

With regard to potash, the Dodds experiments have been fairly concordant in shewing an increased yield and an increased profit from its application, and I think that to such soils as those at Dodds, deficient in potash, we can safely apply from 40 to 60 lbs. of potash per acre in the form of sulphate, and rely that the application will be profitable. At the same time I think that in Barbados the question of potash applications require careful and continued investigation both in the black and the red soils, conducted in triplicate with an adequate method of ascertaining variations of fertility in the fields employed. I shall refer to another source of potash when speaking of phosphates.

Some soils in Barbados are deficient in lime and especially carbonate of lime, and the question may be asked whether it would be profitable to lime such soils. Here I think we may gain some information from Messrs. Harrison and Jenman's results which show that on heavy clay soils under certain climatic conditions, a heavy application of lime in addition to nitrogen and other manures may result in a long continued increase of yield in tonnage and sugar; this may apply to some extent to Barbados soils deficient in carbonate of lime, and the beneficial effects of lime on the operations of nitrification must not be lost sight of; these considerations, in some Barbados soils, render liming worthy of experiment.

Next comes the question of phosphoric acid. I think that the experiments in Barbados have not shewn that phosphatic applications are profitable, and have left grave doubts in our minds as to whether we have not in the past wasted much money in applying manures containing 20 per cent. or more soluble phosphate at the rate of 1 ton to five acres, that is 90 lbs. soluble phosphates per acre. Unfortunately at Dodds no attempt has hitherto been made to ascertain how far the low yields in each of the phosphate plots have been due to the fertility of those plots being less than that of adjacent ones: but it is remarkable that, upon the whole, two separate fields have during recent years given results which, so far as they go, we cannot but admit point against soluble phosphates in such soils poor in carbonate of lime as those at Dodds, that they favour basic slag or guano phosphate or similar easily available phosphates not containing free phosphoric acid, and that they throw doubt as to whether on such soils (receiving farmyard manures before the planting of each crop) phosphates in any form at the present price of sugar are profitable.

It must be carefully borne in mind that it is probably necessary to maintain a certain amount of available phosphoric acid (and potash) in the soil, if a healthy growth of cane is to be produced, but at Dodds the experimental fields, like most cane fields in Barbados, receive each year an application of 20 tons per acre of farmyard manure, which, made from covered pens, supplies 130 lbs. of phosphoric acid per acre (as well as 150 lbs. of potash per acre, and 100 to 170 lbs. of nitrogen and potash per acre). It is possible that this phosphoric acid is capable of maintaining the necessary amount of phosphoric acid in the soil and supplying the needs of the cane plant; and leads us to include in our enquiries how far all or any of the mineral constituents required by the cane can be supplied by our present applications of farmyard manure, how far they can be supplied by that contained in leguminous green dressings (drawn by their deep roots from depths untapped by the roots of the cane and rendered available by after decomposition), and how far, if we diminished our applications of farmyard manure substituting green dressings, we should have to increase our mineral applications, as well as, active nitrogenous ones.

In connection with the favourable results given at Dodds by the plots receiving basic slag phosphate, I think that this result may be partly due to the beneficial effect on the activity of the soil organisms of the basic nature of the compound of phosphoric acid, in fact of the alkalinity of the manure due to the excess of lime.

The experiments at Dodds have not enabled us to draw conclusions applicable with certainty to richer and better black soils or to the red soils of the island, nor to the difference to be adopted between plant and ratoon canes; but aided by the results of the practice of the best local planters, I am of opinion

that we can for the present make the following provisional recommendations for Barbados:—

(a)—For soils rich in carbonate of lime.

	Plant Canes.	Ratoon Canes.
Nitrogen	60lbs. per acre.	80lbs. per acre.
Soluble phosphate* ... ... (in mixtures containing superphosphate or dissolved guano)	40lbs. per acre.	30lbs. per acre.
Potash	40lbs. per acre.	30lbs. per acre.

(b)—For soils poor in carbonate of lime.

	Plant Canes.	Ratoon Canes.
Nitrogen	60lbs. per acre.	80lbs. per acre.
Phosphoric acid ... .. (from basic slag or guano)	45lbs. per acre.	30lbs. per acre.
Potash	40lbs. per acre.	30lbs. per acre.

The nitrogen should be divided between two applications; say in June and August. The larger application in June may be derived either from guano, or ⅔ from sulphate of ammonia and ⅓ from nitrate of soda. While the August application may be derived from either sulphate of ammonia or nitrate of soda.

The following are some of the principal questions intended to be answered by the manurial experiments started in Barbados during the years 1898 and 1899:—

Under given conditions of soil and climate what amount of nitrogen can be profitably applied to *(a)* plant *(b)* ratoon canes?

Is that nitrogen best applied in the form of sulphate of ammonia or nitrate of soda, or a mixture of both?

At what time or times should that nitrogen be applied?

What is the comparative effect of applying (in the case of *(a)* plant *(b)* ratoon canes) in different forms, proportions and times: (1) Nitrogen only; (2) Farmyard manure and nitrogen; (3) Phosphoric acid, potash and nitrogen: (4) Farmyard manure, phosphoric acid, potash and nitrogen; (5) Farmyard manure phosphoric acid and nitrogen; (6) Farmyard manure, potash and nitrogen?

Can the profitable application of nitrogen be increased by increasing the application of phosphoric acid and potash?

What is the effect (with and without farmyard manure) of, in addition to nitrogen and potash, applying superphosphate of lime in different proportions and at different times, to *(a)* plant, *(b)* ratoon canes?

What is the effect (with and without farmyard manure) of applying in addition to nitrogen and potash, basic slag in different proportions to *(a)* plant *(b)* ratoon ,canes?

What is the effect (with and without farmyard manure) of applying, in addition to nitrogen and phosphoric acid, sulphate

* NOTE:—Equal to phosphoric acid 18 lbs. per acre for plant canes and 11 lbs. per acre for ratoon canes.

of potash in different proportions and at different times, to *(a)* plant *(b)* ratoon canes?

Is any part of the effect of basic slag due to the excess of lime contained in it?

Is the failure of superphosphate in some soils due to the presence of free phosphoric acid?

It will be seen in the above experiments that the investigation of the effect of adding or with-holding farmyard manure, and the treatment of ratoon canes relative to that of the plant canes, are given a prominent place in the experiments. In the future experiments, the following questions already indicated in these notes will be investigated.

Can trash *(a)* turned in, *(b)* allowed to remain and rot on the surface, replace with or without mineral manures and/or leguminous green dressings and/or nitrogen the present application of farmyard manure?

How far can leguminous green dressings replace (1) farmyard manure (2) nitrogenous applications?

What is the best way to treat leguminous green dressings?

What is the best leguminous green dressing for Barbados?

DISCUSSION.

Hon'ble Francis Watts (Leeward Islands): Professor Harrison has covered an enormous amount of ground. He has also raised many points, some I think we are thoroughly agreed upon, but some contain matter for further investigation. He referred at the outset to the fact that Antigua occupies an exceptional position in the question of manuring the sugar cane; because in that island the application of nitrogenous manures had apparently not proved remunerative. He draws that deduction from the published reports of experiments conducted at the Experiment station, Antigua, on similar lines to those conducted in Barbados. It should however be borne in mind, that almost concurrently with the establishment of the Antigua station there was a phenomenal outbreak of disease in the sugar-cane; and no place suffered more than the Experiment station. Therefore when Professor Harrison finds among the Antigua records that the plots there had not produced the same results with nitrogenous manures as plots in Barbados, he must remember that the conditions then existing at Antigua were distinctly unfavourable and the results were not normal. Although we put our notes on record, they should under the circumstances be accepted as a study in disease and not as a study in manuring sugar-canes. Professor Harrison is well aware that I have all along been interested in the question of the application of phosphates. I found at the Antigua station, but again under conditions influenced by disease, that an increased use of phosphates did not bring increased returns. That experience I find supported by the published reports in connection with sugar cane experi-

ments in this island, and by Professor Harrison himself, when in Barbados. I am of opinion that a good deal of useful work could be done in relation to this question of phosphates supplied to the sugar cane. I am the more convinced of this as a gentleman in England, interested in sugar cultivation in the West Indies, lately asked me if I had any views on the question of phosphates in relation to the yield of sugar as he found that large crops of canes were being raised on soils in which it was almost impossible to detect phosphates by analysis, and the application of phosphates to such land did not bring the increased return which they had anticipated. The phosphatic manuring of the sugar cane is a question that is by no means solved at the present moment. Again with regard to lime, we have given far too little attention to this subject. In fact, we have overlooked it because we believed that there was enough lime in the soil in many of these islands. When in Jamaica I was struck by the result of the analyses of red soils overlying a bed of limestone. The soil was only two feet deep, and I was surprised to find that it contained mere traces of lime. There is evidently something wanting in our methods of analyses, as, where soils are distinctly deficient in some necessary constituent, this fact is not sufficiently brought out. I support what Professor Harrison has said respecting the desirability of adopting a uniform method of setting forth the analyses of soils. That subject should be dealt with at a special meeting of the Chemical officers now present. The question of lime may present itself in either of two aspects: first, the lime may be essential as a plant food; or secondly, it may occupy a position in relation only to those chemical changes which go on in the soil. With regard to pen manure, it is the uniform practice in Antigua to apply pen manure to the whole of the fields before the canes are planted. It has more than once been pointed out to me that this practice might to some extent interfere with our investigations as to the demands for plant food on the part of the cane plant. The point ought to be settled whether our manurial investigations are to be carried on on soils which are already manured with pen manure, or those that are left entirely unmanured. Hitherto, the practice has been adopted both at Barbados and Antigua to add the artificial manures to the pen manure, previously applied. The question is whether in this way we supply a sufficient amount of phosphates and potash, and, perhaps in some cases, of nitrogen for the full development of the plant. It is obvious that pen manure made up in the open field and washed by rains is likely to contain very little nitrogen. If we compare the result obtained in any one year by the amount of nitrogen given in the form of sulphate of ammonia with the nitrogen contained in any given sample of pen manure, we may not be comparing things quite fairly, because pen manure supplies many other ingredients besides nitrogen for instance, it also supplies humus. A definition is necessary of what we actually mean by pen manure. Are we to use it as a measure of organic matter, or of nitrogen, or of anything else. Whatever it is, it requires to be settled. I am afraid that if I were to deal with the many other questions raised by Professor Harrison I should detain you for an undue length of time. I only hope that when the paper is

printed, it will lead to further discussions on sugar-cane experiments and tend to a method of levelling and uniformly stating results obtained at all the Stations in the West Indies.

Professor P. CARMODY: As Mr. Watts has remarked, there are certain points brought out in Professor Harrison's paper on which we are all agreed, and there are certain other points on which we do not agree. I hope that, as the outcome of this Conference, many of the points which Professor Harrison has submitted, and with which we do not agree, will be experimented upon and investigated in our larger stations. As to the question of uniformity of procedure and uniformity of reports to be submitted to the public, I agree with the suggestion that has been made to refer these to a small Committee of Chemists and Botanists. It is a subject in which many at this Conference have no interest whatever. With reference to pen manure, it appears that a great deal too much expense is incurred in Barbados in preparing pen manure. The quantity of mould mixed with trash must add considerably to the expense. In Trinidad that is not done and the pens are almost invariably covered. There is an arrangement also for collecting washings. Then in Trinidad, we have, as you know, very heavy clay soils, and the application of pen manure to such soils is organically advantageous. We look upon it partly in the nature of a green manure. I have also found in my experience in Trinidad results which correspond to those spoken of by Mr. Watts - very small proportions of potash and lime in the soils, and yet crops remarkably heavy in their yield. We have noticed especially an extraordinary deficiency of lime in our soils. These are points which I hope will be taken up by the Department of Agriculture with a view to throwing more light upon them.

Mr. J. R. BOVELL: From the analyses which Professor Harrison made at Ashbury Estate, Barbados, it appears that from the average quality of farmyard manure used there, it was estimated that at the rate of 100 pounds of phosphates and 100 pounds of potash were applied per acre. I admit that farmyard manure is better prepared under cover; but in spite of that I am of opinion that it contains a considerable quantity of plant food.

The PRESIDENT: Do you consider as applied in Barbados it is a cheap and effective means of supplying the ingredients you have mentioned to the land?

Mr. BOVELL: I do not say it is cheap because in some cases too much mould is used.

Mr. A. P. COWLEY (Agricultural Society, Antigua): In Antigua we grow our canes considerably cheaper than a great many places. We use no artificial manure to our plant canes, but we apply a large quantity of pen manure. How does that affect the cost of growing canes? I should be sorry to see pen manure done away with. As to cost, it works out to about 40/- or 50/- per acre. With regard to the preparation of pen manure, we do not go in largely for field or open-air pens, our pens are mostly near the works and all the rubbish that would otherwise be wasted is collected and put in the pens. The cane tops come in as food for the cattle, and the rotten canes are put in the pens. Whether the fungus is thus destroyed

ments in this island, and by Professor Harrison himself, when in Barbados. I am of opinion that a good deal of useful work could be done in relation to this question of phosphates supplied to the sugar cane. I am the more convinced of this as a gentleman in England, interested in sugar cultivation in the West Indies, lately asked me if I had any views on the question of phosphates in relation to the yield of sugar as he found that large crops of canes were being raised on soils in which it was almost impossible to detect phosphates by analysis, and the application of phosphates to such land did not bring the increased return which they had anticipated. The phosphatic manuring of the sugar cane is a question that is by no means solved at the present moment. Again with regard to lime, we have given far too little attention to this subject. In fact, we have overlooked it because we believed that there was enough lime in the soil in many of these islands. When in Jamaica I was struck by the result of the analyses of red soils overlying a bed of limestone. The soil was only two feet deep, and I was surprised to find that it contained mere traces of lime. There is evidently something wanting in our methods of analyses, as, where soils are distinctly deficient in some necessary constituent, this fact is not sufficiently brought out. I support what Professor Harrison has said respecting the desirability of adopting a uniform method of setting forth the analyses of soils. That subject should be dealt with at a special meeting of the Chemical officers now present. The question of lime may present itself in either of two aspects: first, the lime may be essential as a plant food; or secondly, it may occupy a position in relation only to those chemical changes which go on in the soil. With regard to pen manure, it is the uniform practice in Antigua to apply pen manure to the whole of the fields before the canes are planted. It has more than once been pointed out to me that this practice might to some extent interfere with our investigations as to the demands for plant food on the part of the cane plant. The point ought to be settled whether our manurial investigations are to be carried on on soils which are already manured with pen manure, or those that are left entirely unmanured. Hitherto, the practice has been adopted both at Barbados and Antigua to add the artificial manures to the pen manure, previously applied. The question is whether in this way we supply a sufficient amount of phosphates and potash, and, perhaps in some cases, of nitrogen for the full development of the plant. It is obvious that pen manure made up in the open field and washed by rains is likely to contain very little nitrogen. If we compare the result obtained in any one year by the amount of nitrogen given in the form of sulphate of ammonia with the nitrogen contained in any given sample of pen manure, we may not be comparing things quite fairly, because pen manure supplies many other ingredients besides nitrogen—for instance, it also supplies humus. A definition is necessary of what we actually mean by pen manure. Are we to use it as a measure of organic matter, or of nitrogen, or of anything else. Whatever it is, it requires to be settled. I am afraid that if I were to deal with the many other questions raised by Professor Harrison I should detain you for an undue length of time. I only hope that when the paper is

printed, it will lead to further discussions on sugar-cane experiments and tend to a method of levelling and uniformly stating results obtained at all the Stations in the West Indies.

Professor P. CARMODY: As Mr. Watts has remarked, there are certain points brought out in Professor Harrison's paper on which we are all agreed, and there are certain other points on which we do not agree. I hope that, as the outcome of this Conference, many of the points which Professor Harrison has submitted, and with which we do not agree, will be experimented upon and investigated in our larger stations. As to the question of uniformity of procedure and uniformity of reports to be submitted to the public, I agree with the suggestion that has been made to refer these to a small Committee of Chemists and Botanists. It is a subject in which many at this Conference have no interest whatever. With reference to pen manure, it appears that a great deal too much expense is incurred in Barbados in preparing pen manure. The quantity of mould mixed with trash must add considerably to the expense. In Trinidad that is not done and the pens are almost invariably covered. There is an arrangement also for collecting washings. Then in Trinidad, we have, as you know, very heavy clay soils, and the application of pen manure to such soils is organically advantageous. We look upon it partly in the nature of a green manure. I have also found in my experience in Trinidad results which correspond to those spoken of by Mr. Watts—very small proportions of potash and lime in the soils, and yet crops remarkably heavy in their yield. We have noticed especially an extraordinary deficiency of lime in our soils. These are points which I hope will be taken up by the Department of Agriculture with a view to throwing more light upon them.

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is a matter on which I should like authoritative information. Some in Antigua are under the impression that it is; but I should like to know whether in putting the rotten canes in the manure pens we are doing a good thing or a bad one. With regard to lime although I live on a lime estate, during the last few years I have burnt lime and applied it with very good results. With regard to statistical papers and records, I would suggest that they be distributed amongst the planters as well as to the Experiment stations and that there should be more uniformity in tabulating them than at present.

The PRESIDENT: In reply to the question submitted by Mr. Cowley there can be no doubt that the practice of throwing rotten canes on manure heaps is not to be commended. The fungoid disease affecting sugar-canes known as *Trichosphaeria* has one or more resting spores. These are not likely to be destroyed by fermentation and hence will be carried with the manure into the field and attack the canes. It would be better to pass the rotten canes, as soon as possible, through the mill and burn the megass in the furnace. This is the only effective way of dealing with them. I have noticed in this and other colonies that it is not an uncommon practice to allow a heap of rotten canes to remain in the yard and gradually decay. Nothing can be more favourable for the spread of both the moth-borer and fungus. It is useless under such circumstances to attempt to deal effectively with either pest.

Hon'ble F. J. CLARKE (Barbados): There is one question I should like to ask my scientific friends. Whence does the manure derive its phosphates and potash?

Professor HARRISON: In Barbados in applying pen manure you are not adding anything to the soil of your plantations. You are only transferring something from one part of it to the other. The large addition of soil to the manure simply adds to the weight and increases the cost of transportation.

Rev. DR. MORTON (Agricultural Society, Trinidad): It appears to me that in this discussion we have very much overlooked the small man. I think we ought, if possible, to give some hint to small cultivators how they should deal with the question of manure. In country villages a considerable quantity is thrown out by people who do not require it. I made some experiments with a view to solving the problem. My plan was to remove the manure to my land at once and cover it with the soil. The results were very good indeed. A small holder in my neighbourhood did the same. He had no animals of his own, but took the manure from his neighbours, gathered all the leaves which fell from his trees, the sweepings of his yard, and threw the whole into his field, and he got almost actually the same result as I did. He was a Barbadian and knew the value of manure. It seems to me that the treatment of waste products—leaves of trees, house water, manure from animals, grass, straw—by handling them quickly and burying them in the soil, is the only solution so far as our small cultivators are concerned. I should like to emphasize, especially in the interest of these small cultivators, the necessity of not wasting a single particle of manure, but to get it into the field

and quickly cover it up—especially in dry or in very wet weather. In some cases a large quantity of manure is carried out and left uncovered in the field; a heavy rain comes down, and all the main food is washed away. In other cases it is applied when the soil is not in a fit state to receive it. I think we should try and get our people to save all waste products and return them as quickly as possible to the soil. If we do that, we shall encourage them as cane farmers and enable them to maintain their cultivations over a number of years.

Mr. Hart (Trinidad): There is one point which the chemists have not touched, and that is, the actual application of manures to the soil. I believe that as much uniformity is required in the method of applying manures to the soil as in analyses or any other proceeding in relation to cane cultivation. There is no doubt that manure applied in small quantities is at times much more useful than if applied in large quantities, and that manure is required at times in larger quantities than at other times. One man may use half a ton of manure and get the same results as another man who may have used a ton, simply owing to the different methods of application. I think that experiments in this direction are required so that we may ensure uniformity in the application both of chemical and pen manure.

The PRESIDENT: Numerous points, many of them of great interest, have been brought before us in the papers read by Professor Harrison and Mr. Jenman, and in that by Professor d'Albuquerque. We cannot fully discuss them to-day; but I hope that when the papers are published they will suggest useful experiments for the coming year and direct attention to matters still requiring to be definitely settled. What has been said about the doubtful value and economy of pen manure I understand applies to manure prepared in the open field, where it is washed by rain, and in cases where an undue quantity of soil or mould is added, reducing its quality and increasing the cost of transportation. Pen manure, prepared under cover and not overloaded with soil, wherever it can be economically produced, is undoubtedly a valuable application to cane fields. The criticism to-day has been directed only against pen manure in cases where the cost far exceeds the value. The Rev. Dr. Morton has reminded us of a considerable field of enquiry, in regard to the treatment of waste products and their conversion into manure by cane farmers and small cultivators. Mr. Hart has usefully drawn attention to the fact, that the value of any manure largely depended on the period in the plant's growth when it is applied, and also the quantity at any given time.

NOTE ON ARTIFICIAL CROSS-FERTILIZATION IN THE SUGAR CANE.

BY PROFESSOR J. P. D'ALBUQUERQUE, M.A., F.I.C., F.C.S.

Island Professor of Chemistry in chemical charge of Sugar Cane Experiments.

The discovery that the sugar cane produces fertile seed, from which can be reared canes of the most varied size, habit and richness of juice, has opened to cane growers all the potentialities of the wonderful means of variation embodied in the fertilization of the oosphere or the fusion of two different cells. The researches of Messrs. Harrison and Jenman, more than any others, have been directed to investigate the relations between the mother parent cane and its seedling progeny, which all ideas and conclusions on the subject of heredity compel us to believe must exist between the qualities of parents and their offspring: and these researches have shown relations of an important kind. They have shewn that, as a rule, "the average size of the [mother] variety" . . . "closely governs" [with exceptions] "the size of the offspring" that the same may be stated in regard to colour; but the sugar contents of the juice, glucose ratio and quotient of purity, present in the offspring very wide variation on both sides of the mother variety, so that to quote their words a "seedling from the Mani cane" . . . "is equally likely to contain only 1 pound sucrose per gallon in its "juice as against 1·7, about what the parent variety averages, "whilst it may contain 1·9 pounds:" and they tell us "to obtain canes richer in sugar than the Bourbon and other old established varieties we are compelled to proceed purely on experimental lines by selecting the finest seedlings of a few appreciated varieties, and, from among them, picking out, after a few years' study of them both as plants and ratoons, those which give the greatest yield of cane of the highest saccharine strength and purity." It would appear therefore, from these researches, that the size (and colour) of seedling canes varies to a moderate extent on either side of the mother variety, and that, in order to improve the cane in the latter respects, we must trust to repeated trial to give us the canes we seek for.

It takes about two years to rear a mature cane from seed, and some few years longer before the characters of the seedling cane have been sufficiently investigated to be pronounced upon. While some characters, viz. saccharine richness, are probably fairly permanent from the first, others, such as vegetative vigour and tendency to tiller, shew a falling off in the canes grown from cuttings; and it takes some time before the condition of stability or equilibrium is attained, and, in the course of those years, many of the seedlings will be rejected from one cause or another. A seedling which may give very good results in one soil, may prove a failure when distributed over even such a small variety of soil and climatic conditions as are afforded by a small island like Barbados. I can call to mind promising seedlings which have, in some places, broken down under this test. While, therefore, the method of mother pedigreed cane seedlings as practised by Messrs Harrison and Jenman offers great advantages over the hap-hazard choice of seedlings in

which no record is kept of the parent, while it offers all the potentialities of the seedling with an important attempt to shorten the process of selection, it still, as far as I am able to read their reports, leaves the paternal plant, that is the source of the pollen, undetermined, and still leaves the risk that we may wait a long time for the cane we are looking for, and renders it very desirable that we should carefully consider any further method of abbreviation which the practice and experience of Botanists or Horticulturists may suggest: and it is with a view to opening a discussion that I venture to bring to your notice the importance of carrying out a systematic series of experiments on artificial cross-fertilization, a process which involves the fertilization of the mother cell by pollen from a selected plant of another variety, and therefore involves a selection of both the maternal and paternal plants from different varieties.

If we have any faith in the theory of heredity which has so splendidly cleared up and explained a large number of important facts in biology, or even if we have faith in the facts themselves, we cannot help being driven to the conclusion that every character presented by the cane seedling is derived from potencies which existed in one or other of the parents, that no new character can appear in the seedling which did not exist, manifest or latent, in one or other of the parents, and that the characters of every cane seedling have been derived from, and are a combination in different proportions of. the characters, manifest or latent, possessed by the parent varieties: that by selecting both parent varieties we shall incorporate characters from *both* parents in varying degrees, produce some seedling canes possessing, in higher than average proportions, desirable characters from *both* parents, and so shorten the time to the production of the cane we are seeking for.

I am not aware that any systematic attempt has hitherto been made to bring this principle (so largely used by seed growers) into operation in the production of the cane seed. Indeed, though it is highly probable, it has not, as far as I know, been actually proved that cross-fertilization takes place at all in the case of the sugar cane. Messrs. Harrison and Jenman in their report of 1890 mention one cane where there is some probability that the source of the pollen was known, because only one variety of cane in a large district was flowering at one time.

The cane flower if not self-fertilized is probably wind-fertilized. Is it possible to effect artificial cross-fertilization in the cane? and if so, how? I can think of three ways in which it can be attempted.

The first is to take advantage of any two varieties of cane which arrow together, while other canes are not arrowing in the same district. This method is not one which would appear to be available in any district (such as Barbados) where, a large number of varieties being under cultivation, it would be next to impossible to ensure against the risk of pollen coming from an unknown source.

A second method would be to grow, side by side in rows, canes of the different varieties it is desirable to cross, and so chosen as to arrow at approximately the same time; bend over

the arrow stalks together and bag them, before the flowers are protruded, in the same sterilised fine silk bag, and when the pollen of each arrow is ripe, its distribution over the other arrow in the same bag will be ensured, either by the wind, or by shaking the arrows in the bag.

The third method which Dr. Morris suggested to me as quite as likely to succeed and more practical than the second one, is to bag each arrow under experiment some time before it is ripe: and when the arrows in the bags are ripe, to shake the contents of the bags of one variety into the bags covering the arrows of another, the latter bags being temporarily open at the top to receive the pollen, and then closed up, every possible precaution being taken to prevent, during the transference, the access of pollen from any other source.

No doubt difficulties will occur in the carrying out of these experiments. Thus a large number of the bagged arrows may fail to produce mature ovules capable of fertilization and so a large percentage of the trials may be unproductive, rendering it necessary to bag a large number of arrows. The second method also would prove much more difficult to carry out than the third, because only a few of the selected adjacent cane holes may arrow in pairs and this again will reduce the percentage of successfully germinated seedlings.

At my suggestion Mr. Bovell has already bagged a number of arrows by method 2 and the result will be of great interest.

It will be obvious to every worker interested in the question of improving the sugar cane, that at present there is no existing cane which combines all the characters, and in the degrees which are desirable from the point of view of the sugar producer. The first and foremost are, heavy tonnage of cane per acre, and richness in sugar: and I suggest that by fertilizing a large number of arrows of some heavy tonnage variety (as rich in sugar as we can find such a variety) with pollen from some variety very rich in sugar (and of as heavy a tonnage as we can find such a variety), we ought to be rewarded with at least some seedlings possessing a larger than ordinary measure of both characters. Other characters that we would seek to incorporate as far as consistent with the above would be early (or at all events "timed") ripening, high and sure germinative power in the tops, resistive power to fungoid and insect attacks, pure as well as rich juice, good milling properties &c.

It must of course be borne in mind that the above suggested methods only ensure that the seedling canes produced are either the products of self-fertilization, or of cross-fertilization between the parents selected. Thus with arrows of parent canes A & B so treated, the seedling canes are either seedlings of A self-fertilized, or B self-fertilized, or of A cross-fertilized by pollen of B, or B cross fertilized by pollen of A. To ensure otherwise would need the elimination of the anthers before they were mature, a very difficult task in a plant the parts of whose flowers are so small as is the sugar-cane.*

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* NOTE:—A similar operation has been successfully carried out by Messrs. R. & J. Garton in their thirty years work upon cross breeding in wheat.

IMPROVEMENT OF THE SUGAR CANE BY "CHEMICAL SELECTION."

BY PROFESSOR J. P. D'ALBUQUERQUE, M.A., F.I.C., F.C.S.
Island Professor of Chemistry in chemical charge of Sugar Cane Experiments.

The next point to which I have to invite the attention of the Conference is the question as to whether it is practicable to enrich any given variety of cane by selecting tops for "seed-cane" from those canes which actual analyses of juice shew to be richest in sugar.

Planters have been blamed for not having already improved their canes by this method, and against the probability of the method proving a success has been urged that the richest canes in a field are often simply the ripest or best nourished, that tops from such richest canes have less germinative power and are more liable to fungoid attack in the young stage, that careful observation has failed to detect bud variation in the sugar cane, and that the high variability of the sugar cane produced from seed shews that seed is a far more satisfactory and probably the only way of increasing the weight and richness of the sugar cane.

Glancing briefly at what has been attempted in this direction, Messrs. Thompson and Edson at Calumet in Louisiana carried on some experiments for about three years and in their report they considered that they achieved some success. On a very small scale an attempt has been made by Mr. Bovell and myself at Dodds Botanic Station over three crops, but as our method (a compulsory one with us up to the present) is very unsatisfactory, we are not surprised that the attempt has been a failure. During the first year's experiments the result was that the plants from the richer canes gave the crop with juice richest in sugar: but the results were reversed in the second and third years. For the plants from the "rich" canes produced canes both lower in tonnage and poorer in sugar than those from the "poor" canes. The experiments were only carried out on small single plots.

At Mauritius Monsieur Boname gives the results of experiments carried out for two years and these results are negative.

Looking at the matter from a theoretical standpoint one cannot help thinking that canes produced from the buds of a parent cane, are likely even if grown under precisely similar conditions (if it were possible to do so) to manifest slight differences in their various properties, such as the length of their joints, the amounts of sugar and other substances in their cells, the germinative power of their buds and so on; one would expect that the canes so produced from buds while exhibiting no striking variation from the parent would oscillate as it were in their properties about the mean formed by the parent plant, and that by selecting the canes richest in one of those properties (say sugar production) the canes produced from the buds of the daughter canes, would oscillate in their properties about a new mean (that of their mother canes) and a mean slightly higher than that of what I may call the grand-mother cane

And one would expect that by a repetition of this process of selecting the richest from which to propagate, the average richness of the variety would be increased. Admitting that it is possible for the sugar cane to contain more sugar than it does now, it does not, in order to test the theoretical possibility of this enrichment, seem necessary to me to shew as suggested those striking variations known as bud variation: the essence of the idea lies in a gradual integration of small differences, and not in a change *per saltum*. But even if it were necessary, we know that bud variations do, though rarely, occur in the sugar cane, from the drawing and striking specimens now exhibited by Dr. Morris at this Conference.

From a practical point of view, however, there is a very great difficulty in carrying out the experiment satisfactorily; and that difficulty is, admitting that in a given variety of cane some individuals possess greater inherent sugar-producing powers than others, how are we to find them? What test shall we apply? For the cane which on any given day has the richest juice may not be the one with the richest potentialities. It may as has already been urged be simply the richest because better exposed to light, better nourished from its position in the stool &c. If on the other hand we do not simply select plants from the richest individual canes, but as suggested by Mr. Kobus select our plants from the stool displaying the highest average richness, may not this again be due to this stool being riper from having germinated a little earlier than neighbouring stools, or being riper from some other accidental cause not inherent in the cane from which it sprung? I confess I do not see any way out of the difficulty and can only hope that by combining all methods, i.e. of selecting the similarly situated richest canes from the richest stools. and doing this with a large number of plants that on the average we may succeed in hitting on a much larger proportion of the inherently richer canes. Dealing with the objection that plants from these richer canes will germinate badly, that a smaller proportion of them will germinate than from ordinary plants, I should say use a variety of great germinative vigour. There is no doubt a limit beyond which a cell of a cane plant can no longer produce sugar and live: a limit of sugar contents beyond which the protoplasmic functions of the cane cell would be so interfered with, so reduced in vigour, that the plant would die or at least be unhealthy; but assuming that the variety experimented with has a fair margin of protoplasmic contents, and so a fair margin of vegetative vigour to be encroached upon, I do not see why the percentage of sugar should not be increased and yet the plant retain sufficient germinative power for practical purposes. All that would be wanted in the ripe cane (in the experimental stage) would be just sufficient germinative power to produce with care and irrigation a healthy plant: this is of course simply in the experimental stage. When the variety in experimental cultivation had been sufficiently (or as far as practicable) enriched, it would be probably planted out in the estates from unripe or less ripe plants, and therefore from plants that retained more protoplasm and greater germinative power than plants from ripe canes.

A purely local difficulty that has rendered such Chemical selection experiments in Barbados unsatisfactory, is the fact that it is not possible, except at great risk of not getting the canes to germinate, to plant out canes after the middle of December in black soils: and the canes from which these plants are taken would not be ripe till March or April following. Now the relative richness of the unripe canes we are testing in December and taking plants from, is not at all the relative richness of the same canes at maturity, and consequently we are probably not selecting the inherently richer canes. This local difficulty however we shall in future obviate by the employment of an irrigated field very kindly placed at our disposal by Mr. H. E. Thorne at "Sandy Lane," which will enable us to plant out at the ordinary reaping time of the variety under experiment.

A METHOD OF ASCERTAINING THE FERTILITY IN DIFFERENT PARTS OF AN EXPERIMENTAL FIELD BY THE USE OF CONTROL PLOTS.

BY PROFESSOR J. P. D'ALBUQUERQUE M.A., F.I.C., F.C.S.

Island Professor of Chemistry in chemical charge of Sugar-Cane Experiments.

In all Agricultural Field Experiments great difficulty is experienced in dealing with the varying fertility of the soil from one part to another: and it is probable that many erroneous conclusions have been due to the neglect or failure to eliminate this source of error. In some cases this factor has been ignored altogether, while in others various methods have been adopted with a view to eliminate it in the conclusions. As far as I am aware, the chief methods adopted have been as follows:—*(a)* the use of very large plots of half an acre upwards; *(b)* the ascertaining of the mean no-manure fertility of the field by leaving diagonal strips right across the field unmanured, and taking this as the mean fertility with which to compare large or small plots; *(c)* the use of three or more plots of each kind and assuming that the mean increase of yield of the three plots of one kind, compared each with the plot in its own series not containing the constituent under trial, gives the true increase due to that constituent; *(d)* the use of small plots in three or more series, each series containing a number of control plots with which to compare the plots of the series. This is the method employed by Messrs. Harrison and Jenman in their experiments, and is a great advance upon previous methods. They compared the yield of each manured plot with the mean of the diagonally situated no-manure plots.

A method which I desire to bring to your notice to-day presents I think a considerable difference from those above enumerated, in that it makes an attempt to ascertain the fertility of each plot in the field. In choosing fields for

manurial or other agricultural experiments, a field as level and otherwise uniform as possible is selected. It should rest upon one geological formation, and from its history it should be known to have been uniformly treated in the manurings of previous years and to have been employed as one field in agriculture and not planted in patches. Notwithstanding all this its fertility, as measured by say the weight of some crop produced on any small unit area, will probably vary greatly from one part to another of the field. The factors the sum of which determine the fertility as above measured are many, and include the quantity of available nitrogen and mineral plant food in the soil, its richness in the bacteria that effect the various changes called nitrification and de-nitrification, its physical condition as to the retentiveness for moisture, aeration and so on. From the manner in which soils are formed and worked in large fields, the value of each of these factors cannot vary suddenly from one point of the field to the next, and if we were to make a diagram in which the horizontal distances showed to scale the position on the field, while the vertical distances shewed the value of any one of these factors, the diagram would consist of a curved surface more or less complicated: and similarly the diagrams representing the changing value of all the factors measured, (if it were possible to do so), in terms of the amount of crop produced, could be combined in one diagram, the diagram of fertility; and this diagram would also be a more or less complicated curved surface. If any way could be devised of finding these curves for the field, it would be possible, having given the weight of the canes of a given variety on any known small unmanured area in the field, to calculate the weight of canes which in the same period would be given by any other unmanured area, great or small, on the same field. It will be observed that in such curves, if the distances between two points on the curve are sufficiently close the curve becomes simple, and when the distance is small enough the curve between the points becomes a straight line. Now we cannot measure the value (in terms of weight of canes or in any other way) of the separate factors the sum of which determine fertility, but we can (and that is sufficient for our purpose) measure at any part of the field the effect in fertility (say for cane growth) produced by the sum of all the factors by weighing the crop produced on that no-manured plot, and the weight of crop will be the measure of the fertility at that spot. If we could afford the time and money we could find the diagram for the whole field by tilling quite uniformly, and growing a crop, say of canes, without any manure, and reaping and weighing the whole field in small plots, which would give the measure of the fertility of the whole field under the climatic conditions of that year; and if the change of soil produced by the growth of the crop were very slight, the diagram of fertility so obtained would probably be approximately correct for the same field for any other year in which the climatic conditions were approximately the same as the year in question: at any rate we could check the assumption by combining it with the method to be detailed immediately.

In practice, however, we generally require, if possible, a

method of finding the measure of the fertility of any part of a field, which can be employed simultaneously with the growth of the experimental plots, and this I suggest can be done, with an approximation to correctness, by employing a number of control no-manure plots at differents parts of the field and so close together that the fertility curve between any two plots can be assumed to be a straight line; from this it will be easy to calculate (in tons of crop per acre) the fertility at any intervening plot. With a view of making the method clear I have made a sketch plan of an imaginary field divided into 169 plots. The field numbers of the plots are indicated in **dark type**: while, indicated in *italics without brackets*, are the weights of crop (say canes) actually found on 25 no-manure plots—control plots. In one section of the field I have filled in, in *italics enclosed in brackets*, the calculated crop yields which each of the plots of that section would give if not manured. Thus plot 1 (control plot) gave, by weighing, a crop of 15 tons; plot 53 similarly gave 19 tons and plot 5, 16 tons. Calculating for the three plots between 1 and 53, we see that plots 14, 27 and 40 respectively would, if not manured, give 16, 17, 18 tons. Similarly calculating for the three plots between 1 and 5, we find that on plots 2, 3, 4, the yields would be 15·3, 15·5 and 15·8 tons respectively. The yield of plot 15 lying diagonally between plot 1 and plot 29 is calculated from the diagonally and closely situated control plots, and similarly the yields of plots 17, 41 and 43 are calculated from the diagonally and closely situated control plots. Plot 31 is situated midway between control plots 5 and 57 and also midway between control plots 29 and 33. The value calculated from the first two control plots would be 18·21, the value calculated from the second two control plots is 18·5. The mean to one place of decimals of these two calculated values is 18·4, and this is the value taken and is enclosed in square brackets. For a similar reason the value for plot 55 is enclosed in square brackets. Thus in every case all available data are used in calculating the no-manure yields. The values for plots 16, 28, 42, 30 are obtained by interpolation between those already calculated.

We can thus ascertain the calculated yield of each plot in the field if it were unmanured: we may call it the no-manure yield of the plot. We also by weighing ascertain the weight of crop actually given by each manured plot. Suppose there are three series of manure plots each series exactly resembling the other except for position in the field. Let (a), (b), (c), (d) . . . &c. represent the respective manures used in each of the three series: let a, b, c, d . . &c. be the corresponding actual yields per acre of these respectively manured plots of one series, and let a_o, b_o, c_o, d_o . . . &c. be the calculated no-manure yields of each of these respective plots.

PLAN OF EXPERIMENTAL FIELD.

1 *15*	2 *(15·3)*	3 *(15·5)*	4 *(15·8)*	5 *16*	6	7	8	9 *17*	10	11	12	13 *16*
14 *(16)*	15 *(16·5)*	16 *(16·8)*	17 *(17)*	18 *(17·2)*	19	20	21	22	23	24	25	26
27 *(17)*	28 *(17·5)*	29 *18*	30 *(18·2)*	31 *[18·4]*	32	33 *19*	34	35	36	37 *18·5*	38	39
40 *(18)*	41 *(18·5)*	42 *(18·8)*	43 *(19·2)*	44 *(19·5)*	45	46	47	48	49	50	51	52
53 *19*	54 *(19·5)*	55 *[19·9]*	56 *(20·2)*	57 *20·5*	58	59	60	61 *21*	62	63	64	65 *19·5*
66	67	68	69	70	71	72	73	74	75	76	77	78
79	80	81 *22*	82	83	84	85 *22*	86	87	88	89 *23*	90	91
92	93	94	95	96	97	98	99	100	101	102	103	104
105 *20*	106	107	108	109 *21·5*	110	111	112	113 *19*	114	115	116	117 *20*
118	119	120	121	122	123	124	125	126	127	128	129	130
131	132	133 *20·5*	134	135	136	137 *22*	138	139	140	141 *23*	142	143
144	145	146	147	148	149	150	151	152	153	154	155	156
157 *18*	158	159	160	161 *17*	162	163	164	165	166	167	168	169 *24*

First Method.

Then $\frac{a}{a_o}$, $\frac{b}{b_o}$, $\frac{c}{c_o}$ . . . &c., are the respective ratios of the manure yield to the no-manure yield of each of these plots. Let O be the geometric mean of a_o, b_o, c_o, . . . &c., for—say the nitrogen plots of one series all close to (a).

Then $\frac{a}{a} \times O$ = mean value per acre due to manure (a) on that *part of the field* and similarly $\frac{b}{b_o} \times O, \frac{c}{c_o} \times O, \frac{d}{d_o} \times O$ are the mean values per acre for manures (b), (c), (d), . . . &c. in that sub-series and $\left[\frac{b}{b_o} \times O\right] - \left[\frac{a}{a_o} \times O\right]$ is the difference produced by the two manures (b) & (a). Suppose the manure

(a) to be minerals only
(b) „ „ minerals + 40 lbs. nitrogen.
(c) „ „ minerals + 60 „ „
(d) „ „ minerals + 80 „ „

then we get the following values for that *part of the field*,

$$\left[\frac{b}{b_o} \times O\right] - \left[\frac{a}{a_o} \times O\right] =$$

$\left[\frac{b}{b_o} - \frac{a}{a_o}\right] \times O$ = mean increase of yield due to 40 lbs. nitrog.

$\left[\frac{c}{c_o} - \frac{a}{a_o}\right] \times O$ = „ „ „ „ 60 „ „

$\left[\frac{d}{d_o} - \frac{a}{a_o}\right] \times O$ = „ „ „ „ 80 „ „

By taking the geometric mean of the value of $\frac{a}{a_o}$ for the corresponding plots in each of the three series, we get $\frac{A}{A_o}$ the mean value of the ratio for the field. By taking the mean yield [O] of all the control plots in the field and multiplying, we get $\frac{A}{A_o} \times [O]$ = mean yield per acre for the *whole field* due to manure (a). and thus we can obtain a mean yield per acre for the field for each manure used : and we obtain the following mean values for the whole field.

$\left[\frac{B}{B_o} - \frac{A}{A_o}\right] \times [O]$ = mean increase of yield due to 40 lbs. nitrog.

$\left[\frac{C}{C_o} - \frac{A}{A_o}\right] \times [O]$ = „ „ „ 60 „ „

$\left[\frac{D}{D_o} - \frac{A}{A_o}\right] \times [O]$ = „ „ „ 80 „ „

Second Method.

Values can also be obtained by taking differences and arithmetic means. Thus b-b_o is the difference between the manure and no-manure yields of the plot receiving manure (b).

a-a_o is the difference between the manure and no-

manure yields of the plot receiving manure (a), therefore
$(b\text{-}b_o)-(a\text{-}a_o)$ = increase of yield due to 40 lbs. nitrogen.
$(c\text{-}c_o)-(a\text{-}a_o)$ = " " " 60 " "
$(d\text{-}d_o)-(a\text{-}a_o)$ = " " " 80 " "

Since all the plots of the nitrogen sub-series (b), (c), (d), . . . &c., are near (a).

By taking the arithmetical mean of the three values so obtained for the three plots of each kind in the field, we obtain the mean increases for the whole field.

Although calculations made by the first method will take more time than by the second method, I prefer the first method, the geometric means and ratios being easily worked by the use of logarithms.

In order more clearly to comprehend the difference between this method and that of comparing the yields of the plots with the mean yields of adjacent no-manure plots, let us look at plot 14 and plot 40. If we compare the respective yields of these plots with the mean of Nos. 1 and 53 the adjacent no-manure plots, we should compare them with 17 tons, whereas by taking the calculated no-manure yield of No. 14 and No. 40 we should compare the yield with 16 & 18 tons respectively, which I submit would make a great difference, since 16 tons is a far more likely yield for plot 14, and 18 tons is a far more likely yield for plot 40 than would 17 tons be for both. By employing for comparison the means of the two no-manure plots, we place each of the three plots between 1 & 53 on an equality, when I submit that they are not so, and that they diverge more and more from equality as they get further apart.

In looking at the capabilities of this method we must bear in mind one or two points of importance. It depends upon the employment of *small* plots of say one-thirtieth of an acre, the employment of control plots close together, and it assumes that the plants or seeds used in each plot are alike: this last condition is a matter of special importance in cane experiments in Barbados, because both tops and cuttings are used, and M. Boname's recent report has clearly shown the greater yield obtained by using tops. It is therefore very important that whether tops or cuttings are used, each plot should begin life on equal terms: whatever we do, slight differences will occur in rapidity of germination and growth, due to slight differences in the plant themselves, and this will be one of the purposes for which we use three or more plots of each kind.

Another point of importance is to recollect that the relative fertility will, in most cases, not be the same between say plots 1 and 150 if those plots each receive an adequate application of a chemical manure (nitrogen, phosphoric acid and potash &c.,), as it is between these plots unmanured. Therefore we should expect the ratio of $\frac{b}{b_o}$ to be different in the different series in which manure (b) occurs, representing the different effects of the same manure on plots of different fertility. By taking the mean of these ratios, if we have the good fortune to hit upon a difference of fertility in the three plots of the

same kind representative of the range of fertility in the field, we shall be able with fairness to calculate $\frac{B}{B_o}$ the mean ratio for the field and $\frac{B}{B_o} \times [O]$ the mean yield for the field, if manured with manure (b).

In the Barbados manurial experiments, besides the no-manure plots, following the plan of Messrs. Harrison & Jenman, there is immediately adjacent to a certain proportion of them, a number of plots receiving each an equal application of chemical manure including nitrogen, phosphoric acid and potash, to ascertain the variation of fertility with such manures: and it may be found desirable to compare the results of the various manures with those similarly manured plots as well as with the no-manure plots.

This method of ascertaining the fertility of the different parts of an experimental field can I think with advantage be extended to variety experimental plots. The plan in this case would be to place control plots of the standard variety, with which all others are to be compared, at intervals about the field; all the plots are manured alike, and the weight of canes per acre of these standard plots will measure the fertility of the respective plots, and by assuming a continuous change of fertility from one control plot to the next, it is easy to calculate what weight per acre of the standard variety each of the intervening plots would give. But the intervening plots have other varieties on them, therefore by dividing the actual weight v of the reaped variety by the calculated weight s of the standard variety for the same plot, we obtain $\frac{v}{s}$ a measure of the relative value of the two varieties. Thus each variety can be compared with the standard one, and thus with one another.

Finally it will be easy to compare results by this method with that obtained by other methods of field experiment and calculation.

I hope during the next year to be able to test the correctness of this method of control plots by leaving an area unmanured, such as that bounded in the plan by corner plots 1, 5, 57, 53, comprising several small plots, and reaping it in separate plots: by comparing the actual results obtained on each of the unmanured plots with those obtained by calculations from the control plots 1, 5, 53, 57 and 29, it will be easy to see how far the method is reliable, and to ascertain how close control plots should be situated, in order that a straight line may be assumed to approximately represent the fertility curve between those plots.

The Conference then adjourned for luncheon. After luncheon the Conference resumed at 2 o'clock.

The PRESIDENT: The first business proposed to be taken this afternoon is to consider the present position of efforts to supply Central Factories to the smaller sugar islands (especially Barbados and Antigua) that are not already possessed of means for manufacturing sugar of a high quality, and at a cost that will enable them to compete successfully in the markets of the world. Until this problem is satisfactorily solved, the efforts of the Imperial Department of Agriculture to be of service to these islands will be seriously crippled. I regard it as of fundamental importance that these sugar islands should be provided with Central Factories, otherwise any benefits arising from raising new varieties of canes and generally improving the cultivation will be neutralised by the loss in the process of manufacture. This loss is estimated at from thirty to forty per cent. It is impossible for any industry to succeed where such a loss is sustained.

Further, the sugar produced is of an inferior kind and is suited to one market, and that a precarious one. Just now West Indian sugar of high quality, owing to the effect of countervailing duties in the United States, realizes about 30/- per ton more than last year. Unfortunately, the low grade sugars such as muscovado largely produced in these islands do not fully share in this benefit. This supplies another argument in favour of Central Factories. It must also be remembered that the United States market may not always be open to us. We have it on the authority of a Cabinet Minister, the present Secretary of the United States Department of Agriculture, that owing to the phenomenal expansion of the beet industry "there is abundant encouragement to lead us to conclude that our country will within a few years produce what sugar it requires." * If muscovado sugar cannot compete in a protected market like that now existing in the United States, it is certain that it must fail in any market where it would come into open competition with beet sugar. It is probable also that all the cane sugar produced in Porto Rico (about 100,000 tons annually), as also the enormously large quantity likely to be produced in Cuba (before the war this amounted to about 1,500,000 tons) will all be shipped to the United States.

Since this time last year you will have noticed that a considerable amount of valuable information has been brought together, but that information only deepens our conviction as to the necessity for immediate and decisive action in regard to Central Factories. I confess that I am not in a position—and I believe no man living is in a position—to suggest any industry that would immediately take the place of sugar in Barbados, Antigua and St. Kitts-Nevis. If these islands are to prosper at all it must be by means of the sugar industry. There is hope for other colonies; for they can profitably grow coffee, cacao, limes, arrowroot, fruit etc., and thus supplement their sugar industries. For the islands I have mentioned there is none.

If, therefore, nothing is done to solve the problem of Central Factories, the sugar industry in these islands cannot hope to sur-

* Report of Secretary, Year book of the U. S. Department of Agriculture, 1897, p. 10.

vive. In order to present the subject in as clear and as concise a manner as possible to this Conference, I have arranged that two papers be read to you by leading men; one relating to Barbados by the Honourable F. J. Clarke, and the other on Antigua, but applicable also to St. Kitts-Nevis, by the Honourable Francis Watts. I will first of all ask Mr. Clarke to be good enough to read his paper on Barbados.

THE PRESENT POSITION OF EFFORTS TO SUPPLY CENTRAL FACTORIES AT BARBADOS.

BY THE HON'BLE FREDERICK JAMES CLARKE,

Speaker of the House of Assembly and Vice-President of the Barbados General Agricultural Society.

As far back as the year 1854, nearly half a century ago, the question of Central Factories engaged the attention of the planters of this Island. In that year an Act was passed by the Legislature, entitled "An Act to encourage the establishment of a Central Sugar Manufactory and Model Farm." The object of this Act was to incorporate a company who proposed to raise a capital of £40,000 for the purpose of purchasing land, machinery, etc., for the improvement of Agriculture, and the manufactures of the Island. Nothing further seems to have been done in the matter.

In 1885 the Agricultural Society appointed a Committee to conduct experiments with a view to determining the relative effectiveness of the different kinds of sugar machinery on three plantations.

The report of that Committtee is one of the many valuable pieces of work done by Professor Harrison in the interest of the sugar industry in this Island.

The result arrived at was that the plantation with the most powerful mill and a vacuum pan obtained 46 per cent. more in value of produce than the other two with less powerful mills and the open system of evaporation.

Professor Harrison was persistent in his advocacy of the advantages to be derived from the establishment of Central Factories.

Planters began to realise the enormous losses which they had been suffering through the lack of proper reaping machinery. The owners of a group of plantations asked the mortgagees to allow them to borrow money on the first securities over the group of plantations, in order to erect a Co-operative Central Factory, but the mortgagees refused. It was therefore clearly

seen that the only way in which Central Factories could be erected was by Government aid.

An agitation more or less vigorous was carried on and we find that in 1894 His Excellency the Governor in his speeech at the opening of the Legislative Session said "I think it will be "granted that with the machinery now in use we cannot pro- "duce more sugar than is done at present, but were the latest "improvements introduced the condition of affairs would be "altered. Not only would the yield of sugar be increased, but "a superior quality could be manufactured. . . . . This ques- "tion has of late occupied much of my attention, and I am "disposed to think, having regard to its financial side, that the "erection of Central Factories is the practical way to these re- "sults and would enable our planters successfully to compete "with the other sugar-growing countries of the world."

A Joint Committee of the Executive Committee and the Agricultural Society was appointed to investigate and report on the question of erecting Central Factories.

Early in 1895 this Committee reported in favour of the erection of Central Factories, and a copy of the Report was sent to the House of Assembly. The Report is a very elaborate one and contains a mass of valuable information collected from all sources.

A Bill to provide for the erection and maintenance of a Central Sugar Factory was introduced into the House of Assembly.

The object of the bill was to erect a pioneer Central Factory on co-operative principles. It provided that the Excutive Committee should be empowered to raise a loan of £50,000 and lend it to the owners of a group of sugar plantations for the purpose of erecting a Central Factory. The owners were to enter into a contract to deliver a certain number of acres of canes yearly to the Factory, and give the Government security over the buildings and machinery and the sugar for the payment of the interest and for provision for a sinking fund to repay the loan.

The bill was unanimously passed by the Legislature and assented to by the Governor, but the Secretary-of-State for the Colonies advised Her Majesty to disallow it on the ground that the security to be given the Government by the planters was insufficient. He said that the Government should have the first lien on the plantations comprised in the borrowing group. The Legislature could not enforce this. They knew that any attempt to interfere with the mortgagees of the plantations would at once wreck the scheme. They pointed out the difficulties to the Secretary-of-State for the Colonies and asked him to reconsider his decision, but he said he was unable to comply with their request, and so this attempt to solve for ourselves the Central Factory problem failed.

Early in 1894, the Agricultural Society had promoted a public meeting to consider the necessity for the establishment of Central Factories. Resolutions were passed setting forth the necessity for Central Factories, and calling upon the Government to aid in their erection. Copies of these resolutions were forwarded to the Governor. The Agricultural

Society also prepared and issued a circular "To the proprietors of Sugar Estates in Barbados, and to all interested in the welfare and prosperity of the Island." In this circular it was proposed that the British Government should be asked to grant the Colony a loan for the purpose of erecting Co-operative Central Factories.

The Report of the Royal Commissioners tended in every way to support the position taken up by the Legislature with regard to the erection of Central Factories, and the House of Assembly on 5th July 1898 again addressed the Secretary-of-State for the Colonies on the subject.

They strongly indorsed the recommendations of the Royal Commissioners, and asked that the measures recommended by them for the relief of the Colony, viz, the erection of Central Factories on the co-operative principle, be taken as soon as possible. The reply to this address was that the views expressed would receive the careful consideration of the Secretary-of-State for the Colonies.

Early last year Sir Nevile Lubbock and Sir Cuthbert Quilter visited the Island, and Sir Cuthbert Quilter made proposals as to the erection of a Factory. The proposals were considered by a Committee appointed by the Agricultural Society, and in their report they stated that the adoption of Sir Cuthbert Quilter's scheme by the planters would be to aggravate the present distress and not to afford relief.

Sir Cuthbert Quilter's proposals were, to erect a Factory to make 5,000 tons of sugar with the necessary light railways etc. at a cost, as estimated by Sir Nevile Lubbock, of £130,000, the planters to contract to supply the canes for ten years at a price not exceeding 10/- per ton delivered into the Factory trucks, and to receive one half the net profits after deducting the expenses of manufacture, and the interest and sinking fund (figured by the Committee at 8 per cent. on the capital) and depreciation 4 per cent.

The half of the profits to be divided between the planters would have amounted to about 1/3 per ton of canes, making a total of 11/3 per ton of canes.

The planter had received about 12/6 per ton for his canes sold as muscovado sugar during the previous five years, so that under this scheme he would have received 1/3 per ton of canes less than formerly. It was strongly urged by the same Committee in a memorandum presented to the Agricultural Society "that Central Sugar Factories are absolutely essential to the continuance in the near future of the sugar industry in Barbados, and that the Agricultural Society should petition the Executive and Legislature to pass an Act, by means of which capital may be obtained to enable owners of land to erect Co-operative Central Factories." The Agricultural Society petitioned the Legislature as recommended, but no steps have been taken to initiate the necessary legislation.

Not only must we have Central Factories in order to avoid the enormous loss that attends the present system of manufacture, by means of small and imperfect crushing machinery, and

open tayches, but to be able to manufacture any class of sugar that may be in demand in the markets of the world.

At present the bulk of our crop is muscovado sugar which has only one market namely the United States, and only one buyer in that market, namely the Sugar Trust.

Tariff legislation may at any moment close the American market to our sugar.

Looking to the rapidly increasing production of sugar in the United States, and to the circumstance that all the sugar from Porto Rico, and very likely all that from Cuba, will go into the American market under favourable conditions it is highly probable that this market will not be open to our sugars beyond another five years.

Central Factories would render us independent of hostile tariffs. It is absolutely essential to our existence that they should be erected. The owners of plantations have not the necessary capital, and mortgagees will not make any concessions, so that Central Factories can only be erected by Government aid, or by outsiders having capital to invest.

We would not derive the full benefit from Central Factories erected by outsiders whose only aim would be to secure the highest possible rate of interest for their invested capital. The cane grower would get very little more out of his canes than he does at present. All the increase in the production of sugar would go to the owner of the Factory.

Central Factories erected by Government aid would be co-operative, and must obviously be more advantageous to all concerned. The planters and the Island generally would be most benefited by the erection, by means of Government aid, of Co-operative Central Factories. The conditions in Barbados are particularly favourable to the successful and profitable working of Central Factories. The cane produced is rich and of high quality. The acreage of canes is sufficient to keep the mills fully supplied. Labour is abundant and carriage to the mill easy.

As I have said, the Legislature has passed an Act to provide for the erection of a pioneer Central Factory but it has not been assented to; the Legislature has also addressed the Secretary-of-State for the Colonies urging him to carry out the recommendations of the Royal Commissioners; the Agricultural Society has petitioned the Government to pass an Act by means of which owners of plantations may be enabled to obtain capital to erect Co-operative Central Factories, and yet we seem to be as far as ever from having Central Factories. What is urgently required is an Act of the Legislature on the lines of the Queensland Sugar Works Guarantee Act of 1893. I am confident that were planters thus enabled to erect Co-operative Central Factories we need have no fear as to the future welfare of this Island.

Failing the erection of Central Factories by means of Government aid, and to avert the awful calamity of being unprepared for the great struggle for existence, shortly to take place in the sugar-world, planters would be wise to nego-

tiate for the erection of Central Factories on the co-operative principle by capitalists.. I think such a scheme as that sketched in Table IV appended to the Report on the proposals made by Sir Cuthbert Quilter, would be advantageous to planters and remunerative to the capitalists.

The Factory to make 5,000 tons of sugar to be erected at a cost of £60,000. The planters to receive 12/6 per ton for their canes, and half the profits after deducting working expenses, 4 per cent. for interest, 4 per cent. for a sinking fund, and 4 per cent. for depreciation.

The profits to be divided between the planters and the Factory would give the planters an additional 1/9 per ton for their canes, or a total of 14/3., and the Factory an additional 7 per cent. on the capital, or a total interest of 11 per cent.

The Factory to become the property of the planters when the sinking fund would repay the capital. After that the profit to the planter would, of course, be greater still. The canes of the last crop of three plantations were weighed, and with as good machinery as there is in the Island, the average number of tons of canes taken to make a ton of sugar was 13·32, thus establishing the correctness of former calculations. A good Central Factory never takes more than 9 tons, so that if these canes had been reaped at a Central Factory they would have made 48 per cent. more sugar than they did.

It is easy to calculate our loss on a crop of 50,000 tons of sugar.

Looking to the facts which I have mentioned, I do not think I have exaggerated the benefits to be derived from Central Factories, or the dire urgency for their speedy erection.

In a post-script to a letter to the *Times* on West Indian affairs, discussing the question of Central Factories, the writer says, "Since the above was written I have been informed that "the planters, encouraged by a favourable turn in the price of "sugar, are less anxious than they were for the establishment "of Central Factories. Such an attitude appears to be deplor-"ably short sighted. A favourable turn in the price of sugar "should afford an opportunity, to be promptly seized, of putting "the industry once for all on a sound basis by the methods "indicated above If the planters let such an opportunity slip, "their best friends will be tempted to say when next they are "in difficulties, that there is no helping those who will not help "themselves." I do not think it fair to say that planters are less anxious than they were for the establishment of Central Factories, for it was in May last when they were getting the slightly better price for sugar that the Agricultural Society sent their petition to the Government, praying that means be provided for the erection of Central Factories, and later in the year a member of the House of Assembly put a question to the Government as to whether they intended to take any steps in the matter. We are anxiously awaiting a reply to our petition, and we hope that the day is not far distant when we may be enabled to put our industry on a sound basis.

THE PRESENT CONDITION OF EFFORTS TO SUPPLY CENTRAL FACTORIES AT ANTIGUA.

BY THE HON'BLE FRANCIS WATTS, F.I.C., F.C.S.

Government Analytical and Agricultural Chemist to the Leeward Islands.

Like the previous speaker I should like to review the situation to show not only what is the present position, but what has been done in the past in Antigua in connection with Central Factories. Planters in the West Indies have been charged with negligence in the matter, and that they do not expend their own efforts. It is true that perhaps some of us who have been endeavouring to stimulate them have resorted to that tone in order to spur them still further to efforts which we believe should lead to improvement. But here, in a Conference like this, I should like to say that those who have seriously considered the question are now fully convinced, that if we do not have in these islands Central Factories for the production of sugar of a high class, in a short time we shall see these islands abandoned so far as the cultivation of the sugar cane is concerned. Some time ago I had occasion to say at a public meeting in Antigua that I foresaw that unless such a step was taken, it was quite within the balance of possibility that the youngest of us would live to see the island of Antigua like that of Tortola. Since then a change has undoubtedly taken place, and I believe a remark of that kind would be received with less incredulity now than it was then.

I find that in 1872 Sir Benjamin Pine, the Governor of Antigua, appointed a Commission to visit and report on the Usines in Guadeloupe and Martinique. I am quite sure that such an active step as the sending of a deputation to other islands was not arrived at without very considerable discussion. Nothing followed. The period between 1872 and 1891 appears to have been quite barren of efforts—so far as the ascertaining of facts was concerned. But in 1891 a visit was made to the island by Messrs. Lee and Foster, proprietors interested in estates, and efforts were made to inaugurate a Company. Steps were taken to float this by private effort, and very little impression was made on the general public. But matters had not gone far before it was found that the support of the general public was necessary, and on 13th February that year, a public meeting was held in the Recreation Rooms, St. Mary's Street. A very vigorous discussion took place, but no conclusion was arrived at. A Committee was appointed to investigate the question, and this Committee held several meetings in the Rooms of the General Board of Health. A sub-Committee was appointed to collect statistics, and this issued a very full report, copies of which are still extant and can be had in the island.

Matters rested until 1893 when another visit was made by Messrs. Foster and Alexander, and they discussed a factory scheme almost entirely with the Governor of the Colony. No public efforts were made. Then matters slumbered

again, and in 1894 I had the honour on February the 4th of reading a paper to the Agricultural Society of the colony on the result of the investigations which I had made in respect to the muscovado industry, and in which I put forward the statement that the annual loss to Antigua from the imperfect character of the muscovado industry was upwards of £50,000. That was followed about two months later by a very useful paper on Central Factories which was read on the May 4th by Dr. Freeland, the owner of a sugar estate and a medical officer practising in the Colony. In this he put forward several suggestions as to the manner in which it should be possible to secure factories, and what was practically a land mortgage scheme seemed to offer the best chance of success. This paper appears in full in the *Sugar Cane* of August, 1894, but the writer is, in error, called Dr. Frankland. That produced a considerable amount of stir in the island, so much so that on June the 1st in that year, at a meeting of the Agricultural Society His Excellency the Governor, Sir William F. Haynes Smith, presented a minute on the Central Factory question in which he suggested the erection of a Government Central Sugar Factory, at or near Skerritts, that being the local representative of Dodds Reformatory in this island. A few days after that, namely on June, the 8th a public meeting was held in the Court House for the discussion of the Governor's minute. The Central Factory principle was unanimously supported, but there was opposition to the suggestion that a factory should be erected by the local Government in the manner suggested in the minute. I may say that up to that time the principle of Central Factories was held to be an objectionable one. Most persons were doubtful whether factories would pay. But at this date, June 1894, there was a marked change in public opinion, and from that time the principle has been generally accepted. On December, the 7th I read a second paper before the Agricultural Society, giving information as to the condition of the muscovado industry and pointing out the need for improved factories. Then matters slumbered again until 1895. On the 1st of March of that year, the Hon'ble H. O. Bennett, President of the Legislative Council, read a paper before the Agricultural Society advocating the erection of factories, and suggesting that the Legislature pass an open Act to encourage the establishment of Central Factories in Antigua and giving an outline of the aid he proposed the Government should offer. This paper was printed by the Society and is obtainable by those interested in the subject. This was followed by a great many discussions at short intervals. As the result of these discussions, in 1896 the matter was brought before the Legislative Council, a Committee was appointed, which drew up a report reviewing the condition of the local sugar industry and recommending that steps be taken for enacting a measure on the lines of the Queensland Sugar Works Guarantee Act of 1893. The Council adopted the report and passed a unanimous Resolution asking that the Government would introduce a Bill on those lines. Everything was however cut short and progress, for the time, delayed by the appointment at that period of a Royal Commission to investigate the position of affairs in the West Indies. You are all

familiar with the history of that Commission—how it visited all the islands, collected valuable information as to their condition and the means of ameliorating the condition of the sugar colonies. The result is the strong emphasis that is placed on the necessity of Central Factories in Antigua and Barbados and other colonies. After the report of the Royal Commission had been issued and no immediate answer seemed to be forthcoming, in November 1897 a telegram was sent in behalf of the planters to the Secretary-of-State for the Colonies asking for countervailing duties, to enable them to compete with the beet sugars in England, and for Central Factories. Hitherto the tendency had been to ask for countervailing duties only, and it is significant that on that occasion the planters combined in the asking of countervailing duties with Central Factories.

Early in last year, on the 17th of February, Mr. E. G. Gill, the representative of Sir Thomas Lipton, visited Antigua and attended a meeting of the Agricultural Society. This meeting strongly supported the proposal that Central Factories were necessary, but the feeling was expressed that 10s. per ton for canes, as proposed by Sir Thomas Lipton's representative, would not materially improve the planters' position. But it is important to notice, that there was practically no dissenting voice in relation to the general principle of Central Factories. Such dissent, as I have said before, was expressed in the earlier history of the movement. Then later in the year, on March 7th, Sir Cuthbert Quilter and Sir Nevile Lubbock visited Antigua and addressed a public meeting in the Court House at which the Governor, Sir Francis Fleming, presided. At this meeting there was a strong feeling in favour of Central Factories, although the detailed proposals of Sir Cuthbert Quilter and Sir Nevile Lubbock did not meet with general acceptance. The history of the conference between those gentlemen and the planters was very similar to the history as occurring in Barbados. Then in May of the same year, Mr. Lee laid before the planters proposals for the erection of a Central Factory on behalf of a Syndicate formed for the purpose. On May the 30th, a meeting of the Agricultural Society discussed those proposals. The proposals were also laid before those interested in sugar properties. While Mr. Lee's proposals were still before the planters, in June Messrs. Harvey and Wilkie, acting on instructions from the Colonial Office, visited Antigua in order to report on the application of the Central Factory system to the island. These gentlemen went all over the island and held meetings at which the principal planters, and those interested in the welfare of the colony were present. On June 3rd, 6th and 17th Mr. Harvey expressed the opinions that Antigua is eminently suited for Central Factories, and that the best site for the first factory would be near St. John's Harbour. Mr. Harvey expressed his views on the subject generally at those meetings, but his report to the Colonial Office has not yet been made public. Practically, as I understood his proposal, it amounted to this: that a factory capable of producing 10,000 tons of sugar was the best suited to the island of Antigua, where the present crop averages from about 15,000 to

18,000 tons; that it should be possible to pay 12s. per ton for canes such as he saw being produced in the colony, and having regard to the past history of the colony; and he also thought that it should be possible for the planter to share, to some extent, in the profits. The planters seemed willing to accept these conditions and there were great hopes that these suggestions would meet with the approval of the Colonial Office. Then we come to last November. On the 14th of that month, Mr. Chamberlain, in reply to a request for information on the part of the Agricultural Society, expressed regret that he was not in a position to report that the difficulties of this question had yet been solved to his satisfaction. That practically sums up the present position of the efforts made to obtain Central Factories in Antigua. We stand confronted with Mr. Chamberlain's answer that he regrets he is not in a position to report that the difficulties of this question have been solved to his satisfaction. We do not know where these difficulties lie, whether they are difficulties which are felt in the financial circles at home or difficulties considered to exist in the country producing the canes.

On the 29th December last a meeting of the Agricultural Society was called to consider Mr. Chamberlain's despatch. At this meeting the need existing for Central Factories was very strongly expressed, and a Committee was appointed to reply requesting that some action may be speedily taken. There is not much to be added in regard to the solution of the Central Factories question, but I think I can say that, in Antigua men's minds are thororoughly made up that they would be in a better position if they accepted about 12s. a ton for their canes, and also that with modern machinery and a scheme not overcapitalized, it would be in the power of a Company or a Factory Syndicate to pay that 12s. a ton, and also perhaps some share of the profits. But there is a diversity of opinion in the island as to how far it would be beneficial to invoke the aid of outside capitalists. At the present moment I do not think there will be any difficulty in getting a factory scheme put forward, and I think I may go further and say that the planters in Antigua, or many of them at least, are quite willing to do what the planters of this colony were unable or unwilling to do at the time referred to by the Hon'ble Mr. Clarke. If aid were forthcoming, planters in Antigua would be willing to give a first lien on their properties for the money advanced to erect and equip these factories. Over and over again there have been demands on behalf of Antigua for a Bill on the lines of the Queensland Sugar Works Guarantee Act, and the only reply received to that request has been that the Colonial Office cannot consider it. No reason why it cannot be considered has ever been suggested. If we were informed that it cannot be entertained for this reason or that, then we might be content to ask for it no longer. But when we are told I speak rather on behalf of the planters—that it cannot be entertained, the reply simply tends to paralyse further efforts. It does not lead to the abandonment of the idea: it leads to nothing. But notwithstanding that reply there is at the present moment a strong feeling in Antigua, that a Bill of a similar character ought to be asked for over and over again. That I

think coincides very much with the position as it presents itself in Barbados. It is felt that unless help arrives speedily it might be too far gone for help to be of any use: for, as the President has already told us, we are sending our sugar into a limited market where we have but one buyer, and that buyer not necessarily kindly disposed to us. But there is one point not referred to, and that is, that we are sending our sugar at the present moment into a protected market, which redeems us from the pressure of the bounty system as effectually as we ask to be redeemed from it in the English market. In conclusion I have to add that the efforts suggested for supplying Central Factories have apparently been made spasmodically. But I think if one reads the facts as mentioned by the last speaker and those I have stated, it will be found that the spasmodic character is due to the fact that after one effort was made a period of waiting was undergone to see what the result would be. Unfortunately, there remains written over the whole of these suggestions the words which Mr. Clarke used more than once—"Nothing further seems to have been done." I hope we may not have to repeat that. I hope we shall not have to say at the end of this year 1900 "Nothing further has been done."

The PRESIDENT: I believe after the valuable papers just read there can be no doubt as to the urgent necessity for Central Factories in Barbados, Antigua and St. Kitts-Nevis. Once these islands are started on a course likely to place their staple industry on a satisfactory basis and in a position to maintain the large communities now depending on that industry, we shall have time to direct our attention to other subjects. I desire, in your behalf, to express our cordial thanks to Messrs Clarke and Watts for the singularly able statements placed before us to-day.

As the time is limited, I shall now, at once, call on Mr. J. R. Bovell to read the first of the papers appearing under his name.

NOTES ON ROTATION AND CATCH CROPS.

BY J. R. BOVELL, F.L.S., F.C.S.

Agricultural Superintendent of Sugar Cane Experiments, Barbados.

A great deal of uncertainty has always existed in Barbados with regard to the exact quantity of lands annually cultivated in sugar canes for the reason that no reliable data have ever been collected. An effort in this direction was made by he Imperial Department of Agriculture some months ago, but

up to the present the data are far from being complete, as many of the forms on which the information was to be supplied have not yet been returned. This is a matter for regret, considering that reliable data as to the yield of sugar per acre are specially required now that there is a possibility of central factories being established in the island.

However, to get some idea of the area of canes annually converted into sugar, and to get the probable value of the food and other crops grown as rotation and catch crops, I have assumed that the area of cultivable land, and the quantity of land under the various crops on the estates, from which no returns have been received, are in the same proportion as those from which the information has been already supplied. In all the calculations in this paper this assumption has been carried out. Later we may have more exact figures.

The following table gives the approximate areas under the various crops.

TABLE I.

Acreage of land in Barbados under various crops:—

	Acres.
Total area of sugar estates (arable land and other) ...	91,638
Area of sugar estates from whence returns were received	40,840
Approximate area of cultivable land on estates of the whole Island	61,427
Approximate area of plant canes	20,378
Approximate area of ratoon canes...	14,620
Total area under canes in one year	34,998
Approximate area of nursery or ratoons for plants ...	958
Approximate area in preparation for canes to be planted for crop of 1901	20,773
Approximate area of the above land in preparation for canes, planted in yams as "catch" crops ...	1,263
Approximate area of land in preparation for canes, planted in sweet potatoes as "catch" crops ...	2,486
Approximate area of land in preparation for canes, planted in fodder as "catch" crops	5,019
Approximate area of land in preparation for canes, planted in green dressings as "catch" crops ...	5,973
Approximate area of land in preparation for canes, planted in crops not specified above	1,220
Approximate area of land in preparation for canes, fallowed	2,154
Approximate area of land under rotation, planted in sweet potatoes	2,172
Approximate area of land under rotation, planted in yams	141
Approximate area of land under rotation, planted in fodder crops	1,519
Approximate area of land under rotation in crops not specified above	258

Although not strictly coming under the question of the

value of rotation and catch crops, it may not be without interest if I mention here that it appears from the above returns, that some 35,000 acres of canes are annually reaped, that the average annual sugar crop of the island for the past ten years, 1889 to 1898 inclusive, is 59,027 hogsheads,* or 51,648 tons. The average yield for the island is therefore 1·4 tons of sugar per acre.

Assuming that 13·5 tons of canes are required to yield one ton of sugar, the average annual weight of canes per acre would be 18·9 tons. That the assumption of about 13·5 tons of canes being required to make a ton of sugar is fairly correct, may be seen by referring to the following table.

TABLE II.

Average results of the reaping of the crops on three well cultivated estates in Barbados, containing steam mills, on which the canes were weighed during the crop of 1899:—

Weight of canes per acre	Tons	17·43.
Quantity of juice per acre	imperial gallons	1975·91.
Quantity of juice per ton of canes	imperial gallons	113·5.
Weight of canes	per ton sugar	13·32.
Yield of sugar	per acre	1·322.

During the period between the time the canes are reaped say from February to June, and the following December or January when they are replanted, it is customary on many estates to grow what are known as catch or intermediate crops of fodder for feeding the estate animals and for green manuring &c. The former are such plants as Indian corn (*Zea Mays*) Imphee (*Sorghum saccharatum*) and Guinea corn (*Sorghum vulgare*); the latter are chiefly Woolly pyrol (*Phaseolus Mungo*), Bengal beans (*Mucuna sp.?*) and Rounceval peas (*Vigna glabra*). Occasionally Guinea corn and Sweet potato (*Ipomœa Batatas*) are also grown and turned under.

It would seem that of the fodder crops some 5000 acres, and of the green manuring some 6,000 acres, are planted annually.

In most instances the plants grown for green manuring are turned under; but it sometimes happens that when the crop is a leguminous one it is fed to the animals, and the resulting manure applied to the land. This latter plan is, from the results of experiments conducted at the Georgia Experiment Station, the one to be preferred.

Under the heads "Approximate area of land in preparation for canes, planted in crops not specified above," and "Approximate area of land under rotation, in crops not specified above,' are included patches of vegetables such as pumpkins, beans &c for home consumption, and plots of Woolly pyrol, Bengal beans etc, grown for the purpose of obtaining the seeds required the following year for planting the "catch" and rotation crop areas.

For the information of those who are not acquainted with local terms I may mention that catch crops are those grown between two crops of canes, while the land is in the course of

*NOTE:—A hogshead is equal to seven-eights of a ton.

being prepared to be replanted. It often happens that the canes are growing before the crops of yams or eddoes, and occasionally Indian corn, are reaped. On the other hand, rotation crops are those grown on lands on which canes are not to be replanted until December of the following year, that is nearly eighteen months after they are reaped.

The following table shows the estimated annual value of the various Catch and Rotation Crops grown in Barbados.

TABLE III.

Catch Crops.	Area Acres.	Value per acre. $	c.	Total Value. dollars.
Sweet Potatoes ...	2,486	12	00	$ 29,832·00
Fodder Crops	5,019	14	08	$ 70,667·52
Green manuring ...	5,973	9	67	$ 57,758 91
Yams	1,263	24	00	$ 30,312·00
Total Catch Crops				$188,590·43
Rotation Crops.				
Sweet Potatoes ...	2,172	32	60	$ 70,807·20
Fodder Crops	1,519	21	24	$ 32,263·56
Yams	141	24	00	$ 3,384·00
Total Rotation Crops				$106,454·76

As far as possible the values per acre of the various crops have been obtained from reliable sources, and are, if anything, rather under than over what is usually obtained.

From the above data, it would appear that the annual value of the catch and rotation crops, of which an estimate can be found, amounts to something like $295,000 or £61,459.

This is no inconsiderable amount and the question arises whether, in view of the present position of the sugar industry, it would not be better if a portion of the £175,000, now sent annually abroad for articles that could be supplied locally, were retained in the island.

There is no doubt, that when the profit on a hogshead of sugar was £10, it was the right thing to do, and in the best interest of the planter, as also of everyone else in the colony, for us to grow as much sugar as we could, and to buy what we wanted in the way of foodstuffs, &c., from others not so fortunately situated as ourselves. Now, however, when sugar is hardly paying the cost of production, why should we not by a system of rotation of crops, supply ourselves with such things as food for the estate animals, all the fresh, and some of the salted meat, most of the butter, some of the cornmeal, and many of the horses and mules that are now imported? By a rotation of crops, less chemical manure would be required; the yield from the fields when planted in canes would be greater, consequently the cost of growing a ton of sugar would be reduced, a matter of great interest in the colony at present.

Some two years ago the Master-in-Chancery, at the request of the House of Assembly, prepared a return showing the profit or loss on the working of the sugar estates under the Court. Anyone referring to this return would see that a very large proportion of these estates had for several years failed to pay even their working expenses. Yet in several instances comparatively large amounts were spent in buying foodstuffs for the animals. To cultivate estates entirely with sugar canes at a loss, and to buy foodstuffs from America, certainly seems to be a mistaken and suicidal policy.

That the food crops grown in the island are fairly remunerative, when compared with those grown in other countries, may be seen by referring to the statement given below, of the comparative value of some of the crops in the United States of America with those grown in this island.

TABLE IV.

Average value per acre of some of the principal crops in the United States for five years, 1894 to 1898 inclusive, compared with the estimated value of some of the Catch and Rotation crops in Barbados.

UNITED STATES OF AMERICA.

Crops.	Yield per acre.	Price per bushel in cents.	Value per acre in dollars.
Indian Corn	24·5 bushels	29·5	6·98
Wheat ...	13·6 „	62·3	8·44
Oats ...	27·1 „	23·5	6·32
Barley ...	23·1 „	37·8	9·09
Hay ...	1·31 tons	7·21 (per ton)	9·26

BARBADOS.

Catch Crops.	Yield per acre.	Price in cents.	Value per acre in dollars.
Sweet Potatoes	4,800 pounds	25 per 100 lbs.	12·00
Yams (*a.*) ...	4,000 „	60 „ 100 „	24·00
Eddoes (*b.*) ...	3,388 „	$1\frac{1}{2}$ „ hole of $2\frac{1}{3}$ lbs.	21·78
Indian Corn ...	10 bushels	80 per bushel	8·00
Cassava (*c.*) ...	12,907 pounds	40 „ 100 lbs.	51·62
Imphee (*d.*) ...	14,080 „	10 „ „ „	14·08
Woolly Pyrol &c. (*e.*) ...	9,671 „	10 „ „ „	9·67

Rotation Crops.	Yield per acre.	Price in cents.	Value per acre in dollars.
Sweet Potatoes (*f.*)	19,591 pounds	34 per 100 lbs.	32·60
Indian Corn (*g.*)...	20 bushels	80 „ bushel	16·00
Guinea Corn ...	12 „	80 „ „	9·60
Imphee ...	21,240 pounds	10 per 100 lbs.	21·24
Guinea Grass (*h.*)	25,904 „	10 „ „ „	25·90

NOTES.

(*a*) The yield of yams on an estate in St. Philip in 1892 was 8,700 lbs.

(*b*) 1,452 holes per acre. This represents the yield on an estate in St. Lucy in 1898.

(*c*) Yield at Dodds on Experimental plot. Cassava sold at 40 cents per 100 lbs.

(*d*) Yield on 3 estates in St. Philip in 1899.

(*e*) Average weight on 7 estates.

(*f*) Average return on 4 estates in different parts of the island.

(*g*) Yield at Hill View in St. John's parish 1899, 31 bushels per acre.

(*h*) 20,904 lbs. were obtained per acre in St. Thomas in 4 months from cuttings.

It is true that the yield per acre of some of the catch crops is comparatively low, but when it is remembered what little care and attention is bestowed upon them, the wonder is that they are not worse.

In addition to the crops mentioned above, which I believe could be profitably cultivated, there is, I think, still room for a greater production of bananas, while one rarely sees plantains for sale. The latter grown in rows 10ft. wide and 10ft. apart in the rows, will yield in the first twelve to eighteen months 400 bunches. These would be worth even at 15 cents per bunch, $60 per acre ; while the year following 600 bunches may be obtained, worth $90, nearly £19 per acre.

There are several other crops such as tanias, English potatoes, ginger and pigeon peas, which I believe would prove remunerative if their cultivation were carefully and systematically undertaken. Pigeon peas are brought here from the neighbouring islands, and sold for from 5 to 7 dollars per barrel. The average yield is estimated at about five barrels per acre. That there is a ready sale for a limited quantity of these peas while green, may be inferred from the following extract, taken from the report of the agricultural correspondent of the Barbados Planter's Journal, for February 1886. He writes, " One gentleman who planted an acre of pigeon peas " as an experiment has sold nearly 100 dollars worth for the " season. "

There are other crops to which I could allude, but I believe I have said enough to show that, even if sugar failed to be remunerative in some districts, there are other crops which may be profitably cultivated, and it would be in the best interest of the island that attention be devoted to them

TABLE V.

Value of Articles imported into Barbados for the Year 1898, most of which could easily be raised in the Colony.

Articles.	Value of Imports. £	Value of Exports. £	Value of Articles consumed in the Colony. £
Oxen, Bulls and Cows	13,335	1,281	12,054
Sheep and Goats	1,930	98	1,832
Horses under 14 hands high ...	406	100	306
Asses	475	25	450
Mules of the value of £12. 10s. and over	5,085	3,100	1,985
Mules under value of £12. 10s.	1,188	...	1,188
Arrowroot, Tous-les-mois and other starches	5,673	1,574	4,099
Butter	15,082	2,501	12,581
Oleomargarine, Margarine and their compounds . .	11,128	3,128	8,001
Cassaripe...	18	...	18
Cocoanuts	1,387	5	1,381
Corn or Maize, Barley and Wheat, unground... ..	15,790	2,742	13,048
Corn Meal	30,581	2,158	28,422
Fruit, Fresh	1,046	25	1,021
Grain, Unenumerated	14,465	1,392	13,073
Hay	1,974	188	1,786
Lard and its Compounds ...	5,820	1,515	4,304
Milk, Condensed	2,295	120	2,176
Oats	23,037	1,960	21,077
Oilmeal and Oilcake	15,634	444	15,190
Onions, Raw	3,656	867	2,790
Pork, salted or pickled ...	33,403	5,174	28,230
Total •	203,408	28,397	175,011

NOTE:—In this table the values are given in round numbers by omitting shillings and pence. The totals however agree with those given in the Barbados Blue Book returns for the year 1898.

The PRESIDENT: Mr. Bovell's paper, just read, should be carefully studied in all sugar-producing colonies. The practical point presented to us is: Now sugar does not pay as it did in former days ought not the planters to grow more food crops and thus save buying imported foods? In Barbados, according to Mr. Bovell, food-stuffs of the value of £175,000 could be beneficially retained in the island. Planters are apparently buying dear American food-stuffs with cheap sugar. This is economically unsound and must add to the prevailing depression in the sugar industry. The moral is: We must conform to our environment and adapt ourselves to changed conditions. If we fail, our industry suffers and in the eventual competition it must cease to exist. Mr. Bovell has another paper on a subject equally interesting and useful.

GREEN MANURING AS A MEANS OF FERTILISING CANE LANDS.

BY J. R. BOVELL, F.L.S., F.C.S.

Agricultural Superintendent of Sugar-Cane Experiments, Barbados.

Turning into the soil certain green crops, raised with that object, is one of the oldest means of improving the fertility of cultivated land. It has been in use over two thousand years. During that time it has formed a most useful adjunct where the supply of farmyard compost is insufficient.

Many advantages result to succeeding crops from ploughing in succulent vegetable substances, such as furnishing the upper layers of the soil with the fertilising material brought up by the long penetrating roots characteristic of the plants used for this purpose, improving the physical condition of the soil and increasing the humus contained therein.

For many years it was observed that the results obtained with one particular order of plants, viz: beans and peas (Leguminosæ) were greater than any other. By degrees it was ascertained that the superiority of these plants over others was due to the fact that after their growth the soil contained a larger amount of nitrogen than could be accounted for by the vegetable matter of the plants and roots. This having been ascertained, the question then arose, where did this excess of nitrogen come from? Was it pumped up by the roots from the subsoil, or was it obtained from the atmosphere? Sir John Lawes and Sir Henry Gilbert—the fathers of agricultural experiments—in England, and Monsieur Boussingault in France, pronounced emphatically against the latter possibility; while Monsieur G. Ville contended that certain plants did acquire free nitrogen from the air.

For a time the question remained unsolved, some scientists

holding one view, some another. Finally, however, the matter was definitely settled by Professor Hellriegel, who by elaborate and carefully conducted experiments, conclusively proved that leguminous plants had the power of absorbing free nitrogen from the atmosphere by means of bacteria contained in the tubercles or nodules on their roots. The manner in which these bacteria assimilate the nitrogen has not yet, I believe, been fully ascertained, although many distinguished men have been, and in fact still are, engaged in studying it.

The existence of this special power of the Leguminosæ, should greatly encourage those engaged in the production of agricultural crops.

As is well known the atmosphere contains nitrogen to the extent of four-fifths of its volume, and when it is considered that there is lying on every acre about 3,000 tons of nitrogen, never to any appreciable extent decreasing, it is imperative upon us to try and utilise some of this inexhaustible supply, instead of paying, as we do in Barbados, some seventeen cents per pound for it in the form of sulphate of ammonia, or nitrate of soda. How this may best be done is a matter for careful consideration and experiment.

While both leguminous and non-leguminous plants enrich the soil, in proportion to their size, in humus-forming material, the leguminous, as stated above, add in addition a large supply of nitrogen; consequently it is desirable for the planter to grow such crops as will effect this object.

In many parts of the world, advantage has already been taken of this discovery with remarkable success.

At a conference held at Dresden, in 1891, Mr. Schultz summarised the results of his experiments with ploughing in leguminous plants as follows: "With a limited stock of fatten-"ing cattle, without buying any nitrogenous manures, by "adding potash, phosphoric acid and lime, I have succeeded in "fixing at the expense of the atmosphere, a considerable quan-"tity of nitrogen, by which I have been enabled to diminish by "50 per cent. the expense of the production of cereals grown "at Lupitz, or what comes to the same thing, to raise the "average profit to 30s. per acre, notwithstanding the unfavour-"able state of the markets."

Another important effect the growth of leguminous plants with their deep root-system has on the crop following, is that the channels made by the decaying roots allow the passage of the roots of the succeeding crop to the lower stratum of the soil, which on account of its depth had retained moisture. From other experiments at the Lupitz farm, it appears, "that "when rye succeeded a crop of lupines, its roots penetrated "over three feet into the earth, and that the roots of potatoes "descended still deeper; but upon land adjoining, manured "with farmyard manure, and not having had a previous crop "of lupines, the roots of the rye descended only between six-"teen and twenty-four inches."

The results of experiments with potatoes on the same farm, with and without green manuring, are said to be 9 tons of well shaped good cooking potatoes per acre, on the green

manured plot, as against 6 tons per acre on the plot manured with chemical fertilisers. The cost of manuring the former was 19s. and the latter 72s. per acre.

At the Georgia Experiment Station, some very interesting experiments with regard to the disposal of crops of cow peas have been carried out, which tend to show that the best results are obtained when the vines are converted into hay.

Director Redding's experiments were as follows,—"In 1893 "a section containing seven-eighths of an acre was in oats, "followed immediately by a crop of cow peas, the latter being "moderately and uniformly fertilised with 200 pounds of acid "phosphates per acre. When the pea crop was in full bloom "and a few ripe peas appeared, the section was carefully divided "into plots. On the first, fourth, seventh and tenth plots, the "vines were permitted to ripen their crop of peas, and these "were carefully harvested, and the dead vines turned under "early in November. On the second, fifth, and eighth plots "the vines were turned under when in full luxuriance of growth. "On the remaining plots, the third, sixth and ninth, the vines "were cut at the proper stage and cured into hay, and the "stubble turned under after frost."

The plots on which the vines were converted into hay yielded hay and cotton in the two years to the value of \$54·85; those on which the ripened peas were picked, a combined yield of peas and cotton of \$43·50; and those on which the vines were turned under green, \$39·50. In a similar experiment covering the years 1892-93 the results were as follows:—The plots from which pea vine hay was taken, yielded hay and cotton to the value of \$55·89; those from which the ripe peas were gathered, peas and cotton to the value of \$50·61; the plots on which the vines were turned under green, cotton to the value of \$42·96; and the other plots on which the vines were mown (at the stage for making hay) and left on the surface, gave a yield of \$44·37.

The Director states, "the two experiments agree with remarkable closeness, and the results may therefore be accepted as decisive; viz:—

(1). That the best disposition of a crop of field peas is to convert the vines into hay.

(2). The next best is to permit the peas to ripen and gather them or pasture them.

(3). Turning the vines under gave the poorest economic re-result."

He goes on to say,—"it may truly be said, that the practice of turning under a crop of pea vines - ready for the mower, and in a few days for the barn and for the cattle—has no more reason to sustain it, than would the practice of turning under a crop of wheat, oats, corn or cotton at its most vigorous stage of growth. Nearly every form of stock food would be a valuable and effective fertiliser, if applied immediately and directly to the soil, but the farmer can no more afford to manure his soil with a crop of pea vines, that are ready to mow, than he can sow good sound wheat bran on his land as a fertiliser."

As has already been stated, the principal reason for using leguminous plants for green manuring is the power these plants have of enriching the soil by storing in it atmospheric nitrogen. It can therefore be readily understood, all else being equal, the primary object is to obtain the plant that has this power most highly developed.

Experiments to this end have been conducted at the Louisiana Experiment Station, and the desirability of obtaining a suitable variety of plant is clearly demonstrated by the fact that the variety of cow pea which gave the largest yield, viz. 289 pounds of nitrogen for three years, stored up over three times as much as the lowest, which only stored 93 pounds per acre for the same period; 289 pounds of nitrogen is equal to about 1,400 lbs of sulphate of ammonia, worth at the present time $50.

The value of some of the Leguminosæ as fodder plants is now being more widely recognized than ever. One writer in a paper read before the Agricultural and Pastoral Conference, held in Queensland in May 1892, when speaking about cow peas stated—"I can say from experience and the testimony of "my neighbours that, chaffed, it is the best milk producer we "have. I fed my horses on it all last winter. They did "their work well, were fat and sleek and looked as well, or "better than those that were corn-fed. Our fowls we feed "on the seed and they lay well. We feed them to our pigs. "Boiled they are a good vegetable and the young green pods "are equal to the snake bean. I do not think there is another "plant grown which is so generally valuable to a farmer."

The plants usually used for green manuring in Barbados are:—

LEGUMINOSÆ.

Woolly pyrol—*Phaseolus Mungo*
Bengal bean—*Mucuna sp.*
Pigeon pea—*Cajanus indicus*
Bonavist—*Dolichos Lablab*
Rouncival pea—*Vigna glabra*
Increase pea—*Dolichos sesquipedalis.*

Of the non-leguminous plants used for green manuring there are:—

MALVACEÆ.

Ochro—*Abelmoschus esculentus*

CONVOLVULACEÆ.

Sweet Potato vines—*Ipomæa Batatas*

GRAMINEÆ.

Guinea corn—*Sorghum vulgare.*

In addition to the above, there are now under experimental cultivation at Dodds the following varieties of cow peas kindly sent me by Mr. E. L. Skeete, B.A., who obtained them from Dr. Stubbs, of the Louisiana Experiment Station. These are principally varieties of *Vigna Catjang*, viz:—Black-eye, White, Clay, Unknown, Red, Speckled, Flax, Red, Black, Coffee, Everlasting, Calico, Red yellow, Hull, Smith's No. 9, New Era, Couch, Saddle back. Also *Dolichos formosus* and *Phaseolus*

helvolus, or St. Helena pea, and *Cyanopsis sp.* from Hindostan. There are also under cultivation the Velvet bean of Florida, (*Mucuna pruriens* var. *utilis*) and a plant locally known as the Horse bean *(Canavalia ensiformis.)*

As they may be of interest I have placed for inspection specimens of the various leguminous plants mentioned above, with bottles of their seeds and specimens in alcohol of the nodules *in situ.*

In Barbados, leguminous crops are treated in several ways some of which are as follows, viz:—

(1) Burying them in the cane holes for several weeks, until they are partially decayed, and then re-burying them on one side of the holes.
(2) Burying them at once on one side of the cane holes.
(3) Burying them at the side of the cane holes with a basket or half basket of farmyard manure.
(4) Burying them in a small hole made at the bottom of the cane hole, allowing them to remain and putting the cane plant through them.
(5) Feeding the vines to the animals.

So far as I know, no experiments have ever been made in Barbados to ascertain the quantity of either the nitrogen or the vegetable matter yielded per acre, from any of the leguminous plants grown for green manuring. It is however proposed that a series of experiments with these objects in view shall be undertaken in the spring. Nevertheless, owing to the courtesy of some of the planters of this colony, I am able to give in the following table the weight per acre of a few grown this year.

Weight per acre of the leguminous plants grown in Barbados during 1899:—

Name of Estate.	Plant.	Pounds of green material per acre.
Dodds	Woolly pyrol	14,284
Durants	Woolly pyrol	11,797
Gibbons	Woolly pyrol	7,344
Oughterson	Woolly pyrol	7,084
Warrens	Bengal bean	6,534
Oughterson	Bengal bean	5,574
Dodds	Velvet bean	14,633

For the sake of comparison the names and yield of half a dozen of the cow peas, which gave the best results at the Georgia Experiment Station in 1894, are given in the following table.

Weight per acre of six of the best of the cow peas grown at the Georgia Experiment Station in 1894 :—

Variety of Cow Pea.	Pounds of vines per acre.
Red Ripper	25,256
Forage or Shinny	21,976
Black	21,812
Unknown	21,730
Red	21,730
Redding	21,648

As the velvet bean has given the greatest weight per acre of all the leguminosæ I have tested as yet, the results of certain experiments made with this plant may be of interest. In a Bulletin recently issued by the Department of Agriculture for the United States of America, it is stated that at the Florida Experiment Station the air-dried shelled beans contained 6·29 per cent. fat, 18·81 per cent. crude protein and 53·5 per cent. non-nitrogenous extract, as compared with cow peas, 5·14 per cent. fat, 20·8 per cent. crude protein and 55·7 per cent. non-nitrogenous extract.

An analysis of the hay of the velvet bean, made at the North Dakota Experiment Station, showed it to contain 5·3 per cent. fat, 16 per cent. crude protein, 20·7 per cent. fibre and 41·8 per cent. non-nitrogenous extract. As a fertiliser the velvet bean compares very favourably with the unknown cow pea and the Spanish pea nut. Comparative analyses of the vines, fallen leaves and roots of these three plants, were made at the North Louisiana Experiment Station, to determine the amount of nitrogen contained in each crop. For the velvet bean it was found that one acre of the vines, leaves and roots, contained 154·2 pounds of nitrogen worth $23·15 cents. An acre of pea nuts contained 193 pounds of nitrogen, worth $28·95, while the 108·5 pounds of nitrogen in an acre of cow peas was worth $16·26. Similar analyses have been made at the Alabama Experiment Station. There a yield of 8,240 pounds of cured vines and fallen leaves, and 1,258 pounds of roots, including about 3 inches of stubble, contained 201 pounds of nitrogen, worth $30·15. There was 2·29 per cent. nitrogen in the cured vines and 1 per cent. in the air dried roots.

Experiments were also made at the Alabama Station to determine the value of the velvet bean as a fertiliser, judging from the yield of succeeding crops of oats and sorghum. The increased yield of sorghum fodder was 3,272 pounds per acre, valued at $12. The yield of oats grown on land where velvet bean stubble had been ploughed under was 38·7 bushels and where velvet bean vines were used, 28·6 bushels; while land on which a crop of crabgrass and weeds had been ploughed under

only yielded 7·1 bushels; an average gain of 26·5 bushels of grain as a result of growing velvet beans on the land the previous year. The average gain was about the same when cow peas were grown

At the Alabama Experiment Station, it was also found, that as good results were obtained from ploughing under the stubble. as from ploughing under a full crop of vines. It is there stated that, as a general rule, it may be considered a wasteful practice to turn under the entire crop, because the feeding value of any leguminous crop is always greater than its fertilising value. A greater profit can be secured in the form of marketable meat products without materially lessening the influence of the leguminous crop on the succeeding one in rotation.

DISCUSSION.

The PRESIDENT: Mr. Bovell's paper, just read, draws attention to the practical bearing on agriculture of one of the most valuable discoveries of recent years. It opens a large and interesting field of enquiry and I trust the officers connected with Agricultural Stations will heartily take up experiments during the coming year. Perhaps in no part of the West Indies has the system of green manuring been so fully carried out as in the island of St. Kitts. Mr. Watts may be in a position to say a few words on this point.

The Hon'ble FRANCIS WATTS (Leeward Islands): I believe the reputation which St. Kitts, as a sugar-growing island, has borne in the past, and even sustains to-day, is largely due to the fact that green dressing has been carried on to a larger extent in that Presidency than in any other part of the West Indies. The subject is one of such great importance that I have resolved to carry on careful experiments in order to determine the varieties of plants which are most useful for the purpose, both in Antigua and St. Kitts. Previous efforts to introduce the system in Antigua have been by no means successful. Whether that is due to the soil or to the incorrect selection of the particular variety of leguminous plant, I am not in a position to say. There is, however, a considerable difference between the texture of the Antigua and St. Kitts soils. In Antigua the soils are stiff and heavy; in St. Kitts they are light and friable.

Mr. HART (Trinidad): A great deal depends on the right selection of the particular plant. My experience is that leguminous plants only produce nodules when exposed to full sun. I am of opinion that it is worthy of experiment to determine whether such plants when grown in the shade, say of cacao trees, are capable of fixing atmospheric nitrogen.

Professor HARRISON (British Guiana): One of the most valuable leguminous plants which has been grown with success in British Guiana as a green dressing is *Phaseolus semierectus*

It is a native and grows commonly in the West Indies.*

Mr. J. R. BOVELL (Barbados): With regard to the question whether leguminous plants growing in the shade are capable of fixing atmospheric nitrogen, I would mention that in cane-fields at Barbados I have come across specimens of leguminosæ growing in shade with nodules on the roots.

Mr. GEORGE S. HUDSON (St. Lucia): I have also found leguminous plants growing under the dense shade of forest trees at St. Lucia and in every case there were nodules on the roots.

SILOS ON SUGAR ESTATES IN BARBADOS.

BY E. E. H. THORNE. F.I.C.

The preservation of fodder and especially cane tops in silos received a good deal of attention in this Island about twelve years ago. Silos were erected at Carrington's, Fairfield, Vineyard, Chapel, Chequer Hall, Halton, Locust Hall, and other estates. It was at this period also that a good deal of attention and intelligence was being brought to bear on preserving fodder crops in silos in England, due to the fact that large quantities of fodder were being lost in consequence of the seasons being wet, when hay could not be properly dried.

It may be advanced as an argument against silos or ensilage, that the system is not carried on to the same extent in England now as it was 12 years ago. This is not due to its inefficiency, but, as Dr. Voelcker imformed me last year, to the fact that the seasons, of late, have been more favourable to hay making.

No doubt the reason why many who formerly took an interest in ensilage in this Island have discontinued the practice, is, that up to two or three years ago they have had good seasons and have been able to plant fodder crops; so the dearth of fodder, after the crop was finished, was not severely felt. Again in some instances the resulting ensilage was not good and acted injuriously on the animals. This was not the fault of the system, but of the way in which it was carried out; as unless care is taken to pack the fodder properly, and maintain a suitable amount of pressure, failure must result. As I hope to show later on, there ought not to be any difficulty in making good ensilage from the various fodders grown in this Island.

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* According to *Grisebach* (Flora Brit. West Indies, p. 197) *Phaseolus semi-erectus*, "corolla purple" is found at Jamaica, Antigua. St. Vincent and extends from Cuba to Brazil and Peru. It is also found in the East Indies (*Hooker's* Flora of British India, ii, p. 201) "corolla deep purple and white." The pod is described as 3 to 4 inches long and about one-eighth of an inch in diameter, rather recurved, with many seeds. It is desirable that mature seeds of this plant be collected and distributed for trial at the principal Experiment Stations in the West Indies. [Ed. W. I. B.]

I am glad to say that I know of eight estates which still continue to silo their cane tops. The proprietor of one of them informed me lately that he wished he could construct more and silo all his superfluous fodder. He also said that one of the advantages of having silos was his being able to silo any fodder that may be ready to be reaped, without having to keep it on the land, thereby getting more time to prepare it for planting the cane crop.

Most of the estates in this island have a very small area of pasturage, consequently after crop is over there generally exists a scarcity of fodder. This is especially the case in a year like the past, when there has been a drought. The result is that the planter in many instances has to purchase hay, etc., to furnish the animals with food, also canes have to be reaped before they are ripe to supply fodder.

Another reason why there is more need of silos nowadays is, that a larger proportion of the land is kept under canes every year than used to be. Ratooning is more extensively done, consequently there is less thrown-out land for fodder crops.

From the above it is evident that the system of ensilage could be profitably adopted by all those estates which now suffer from want of fodder; not only from the standpoint of saving the money or part of it which is now spent in purchasing fodder, but also from having an abundant supply of good food. It is by no means a new experiment, as there is the experience of those who have been carrying it on for many years. I am sure that they would not have continued the system if they had not found it profitable. Further I know that they are greatly in favour of it.

In connection with the interest taken in ensilage during the period I have named, I carried out an experiment for the late Mr. Lawrence at one of his silos at Fairfield Estate, where Reynolds' "Patent Screw-pressure" was used, This is guaranteed to exert a pressure of 200 lbs. per square foot Each compartment of the silo measured eleven feet three inches long, eight feet six inches wide, and nine feet deep; 12,400 lbs. of whole tops were placed in one compartment on the 1st and 2nd of February, and the pressure put on. As the mass subsided the pressure was steadily renewed. On the 24th of April when it was opened, it had sunk two feet eleven inches. The ensilage, when removed, weighed 8,650 lbs, showing a loss of 30 per cent. The following is an analysis I then made of this ensilage.

Moisture (dried 212° F.)	...69·19
Albuminoids	... 1·08
Sugar etc	... 2·17
Fibre	...25·06
Ash	... 2·53
	100·00
Volatile acids (acetic)	·184
Fixed acids (lactic)	·239

The effect which siloing produces on the fodder will

pend upon the manner in which the process is carried out. Undoubtedly there may be a very great deal of waste if the work is badly done; and it is not surprising that people who have seen the bad results, and not the good, should be against the system.

The fermentation which takes place cannot be carried out without consuming some of the fodder. It is a case of slow combustion, and the greater the air supply, the more rapidly the fermentation will proceed. If the air is expelled and kept out by means of heavy pressure the fermentation will die out. Some people when ensilage was first started, considered that if they hermetically sealed the fodder and kept out the air, the fodder would be preserved; but by these means more harm than good was done, as the air within the silo was bottled up, instead of being expelled. When the fodder is put into the silo, a large proportion of the space is filled with air, and if the fodder is to be maintained in good condition, this air must be driven out as well as kept out. Unless this is done, a process of slow combustion will go on, which will first of all attack the most nutritious ingredients of the fodder; and unless checked, will end by destroying the mass so that only a rotten residue unfit for food will be left

The object in siloing fodder is to preserve it as nearly as possible in its original condition, allowing fermentation to take place to a small extent, so as to convert the starchy matter into sugar and to break down some of the indigestible portion of the fodder. If carried out successfully, the temperature rises above 122° Fah. which, as discovered by M. Pasteur, destroys the vitality of ferments. Fermentation cannot start again without admittance of air. As Mr. Woodland Toms remarks:—The preservation is never absolute or perpetual "but to obtain the best results it is necessary to tightly pack "the green fodder in large, smooth-walled silos, and to main- "tain the mass under a continued pressure of 100 lbs. or more "per square foot. The most energetic compression is always "that which gives the best results.

"A very acid product is not the ideal to be worked up to "in making ensilage. In the product that has undergone least "change, alcohol and acids are only found in very minute "quantities. To obtain the best results the expulsion of air is "necessary, and this is secured by heavy weighting. When "thoroughly well preserved, ensilage is devoid of taste and "smell, on first taking out of the silo. It is generally admitted "that, other things being equal, a crop well supplied with sugar "is better adapted for ensilage than one less richly furnished. "It seems to be taken for granted among users of ensilage, "that the forage is rather improved than deteriorated, by a "slight alcoholic fermentation, and this is what M. Goffart "aimed at when he first commenced working. He soon found "however, that in the silo the fermentation is apt to overstep "the mark, and degenerate into acetic and lactic fermentation, "and finally into butyric fermentation and putrefaction. Conse- "quently as M. Goffart found it impossible to hit off the happy "mean in the silo, he now strives to stifle fermentation entirely "He finds that he can readily obtain the desired amount of

used has caused some concern. In many instances, especially where mechanical pressure is used, only a few planks are removed, the pressure being maintained, and the exposed portion is cut with a hay knife from top to bottom; when this is used a fresh portion is treated from time to time in the same manner. On the other hand, I have found that if the ensilage is removed in layers, the mass is so tightly compressed that the air does not enter very far into it, in fact only the top layer that is to be used next day is affected. This I regard as beneficial, for it is ready fermented for use the next day, and can be fed straight to the animals. I may here state that ensilage must be perfectly cool before it is given to stock. Where it has been given to them in a warm state bad results have followed, and the ensilage was condemned. Nothing was wrong with the system, but with the manner in which the food was utilised.

The practice, I believe, on most estates is only to cart into the yard sufficient cane tops to feed the stock at night. The remainder is left in the field, and probably some of it is stolen. If all of the tops were taken in every day and put into a silo, a great amount of anxiety and expense to find fodder for the stock, after crop, would be removed. It may be advanced that during crop-time all available labour is employed in getting in the canes. This may be true in some instances, but not in all. No difficulty was experienced during last crop at Sandy Lane in collecting the tops. One four-wheel cart and four mules, and one two-wheel cart and two mules were set apart for this purpose. Payment at the rate of two shillings per acre was paid for picking up and loading the tops, and at one shilling and sixpence per acre for carting and packing them in the silo; one and a half cents (three farthings) were paid for placing each block of stone, and taking it off again. For putting on and taking off weights, one dollar eighty cents (7/6) per compartment was paid. The four compartments of ensilage cost forty four dollars sixteen cents (£9. 1. 0.) in labour. I have roughly estimated the contents of the four compartments to have weighed not less than 168,000 lbs., which makes the cost of the ensilage to be just over two and a half cents (one penny farthing) per 100 pounds.

With reference to siloing other fodder crops, I know of one proprietor who places his sour-grass in silos; he cuts it when it is ripe, and thus secures a uniform growth, which is not the case when it is fed direct to the animals, and cut in patches; with the risk in the latter case, that some of it gets hard and dry before it can be used. By siloing it, you not only keep it in a palatable form, but some of the fibre is broken down and rendered more digestible.

Maize, siloed with the cob on, is considered in America very valuable, and the results obtained by feeding stock exclusively on it are very good. My experience with it is confined to one silo which was opened at Sandy Lane on the 28th of December last: the maize, with cob on, was placed in the silo on the 14th and 15th of September, and the weights put on. It was sufficient to fill the compartment. When opened it had sunk about five feet. The result obtained I consider very satisfactory. The en-

silage was of an olive colour with a characteristic vinous smell. After being cooled it was greedily eaten by the cattle, and mules. At the request of Dr. Morris, I have placed a box containing a sample of this ensilage in the Conference room.

I mentioned just now that one of the benefits of siloing was the breaking down of the fibre, and rendering it more digestible ; in connection with this M. Goffart says :—"Thanks to fermentation, the siloed materials undergo a commencement of decomposition which facilitates the digestion, and increases the nutritive or assimilative power."

Much has been said about the loss in weight of fodder in the process of siloing. Mr. Toms says : "If animals digested and converted to useful purposes the whole of the food they received into their system, then, undoubtedly, loss in weight would be an unmixed evil : and if again the loss fell on easily digested parts, and left the other constituents untouched, then this would make matters worse. But luckily (and this is important), we have evidence to prove that such is not the effect of fermentation on well-made ensilage. There, the loss which occurs falls most markedly on the substances that possess the smallest feeding value."

The PRESIDENT: Mr. Thorne's paper is a very useful one. He has taken a deep personal interest in this matter for many years, and has studied it both from the theoretical as well as the practical point of view. From a personal visit paid to Mr. Thorne's estate, I am convinced that by using silos (where they can be erected at comparatively small cost) they add considerably to the quantity of fodder available for feeding stock and are invaluable during the dry seasons. According to Mr. Thorne's estimate the cost of preserving good feeding material in silos available at a moment's notice does not exceed one penny farthing per hundred pounds. Estates in this island, just now, are compelled to buy rather poor sour-grass at five pence per hundred pounds. In addition they have to cut and cart it long distances. It must cost altogether not less than eight pence per hundred pounds.

The Conference then stood adjourned until Monday morning at 9 o' clock.

CONFERENCE DINNER.

The following report of the Dinner connected with the West Indian Agricultural Conference is taken from the *Barbados Advocate* of the 11th January, 1900:—

The members of the Conference dined together in the spacious dining-room of the Marine Hotel at 8 p.m. on

Saturday, January 6th. The President of the Conference (Dr. Morris) was in the chair. Covers were laid for forty, and besides all the leading members of the Conference and Dr. Morris' official staff, the following guests were present:—

His Excellency Sir James Hay, K.C.M.G., Governor; Colonel Glancy, Officer Commanding the Troops; Sir Conrad Reeves, Kt., Chief Justice; Sir George C. Pile, Kt., President of the Legislative Council; Honourable Ralph Williams, Colonial Secretary; J. Gardiner Austin, Jnr., Esq., Chairman of the Chamber of Commerce; Captain Owen, Superintendent of the Royal Mail Steam Packet Company; Algernon E. Aspinall, Esq., Secretary of the West India Committee; Forster M. Alleyne, Esq., Chancellor of the Diocese.

Dinner over.

Dr. MORRIS rose and proposed "The health of Her Majesty the Queen and the Members of the Royal Family," remarking that at this particular juncture Her Majesty's health would be drunk with more than usual loyalty and deep feeling in consequence of events in South Africa.

The toast was drunk with the accustomed honours.

Sir JAMES HAY then rose and said: Gentlemen—I wish to propose to you a toast which I feel sure will be received with the utmost enthusiasm. It is "The Health of Dr. Morris, and the success of the Imperial Department of Agriculture in the West Indies." It is now just a year ago since I had the pleasure of proposing a similar toast. On that occasion, on the commencement of his labours amongst us, I assured Dr. Morris that he would receive the cordial support of all interested in the welfare of the West Indies. I feel sure you will agree with me that to-day's proceedings warranted the expression of those views. I was deeply impressed with the importance of to-day's meeting. Not only, as I said this morning, had we the highest scientific authorities present, but we had combined with these high authorities the lay mind, in the shape of representatives of the different Agricultural Societies. No matter how scientifically the authorities may discuss questions pertaining to Agricultural Science, it is well for the lay mind to absorb them as much as possible, and to ask questions with a view of eliciting information. My friend Mr. Watts made some very excellent suggestions in his short address to us. One was the uniformity of procedure in carrying out experiments, and recording and tabulating the results. Then I had the opportunity of listening to my friend Professor Harrison. He certainly suggested to us in Barbados one or two lessons which we should take to heart. I think it was clearly proved to us this morning that we are expending a very large, perhaps too large, a sum on what is locally called "pen manure." It might be more economical and advantageous to adopt Professor Harrison's advice. At least, it is worthy of consideration. Dr. Morris, as we all admit, is charged with a very important duty. Much has been done—no one knows that better than myself—but very much more still remains to be done. Your presence here, gentlemen, on this occasion is, I feel sure, a very great gratification to him, because he feels that,

without your support, his efforts will be in vain. I am convinced that there is not one at this table to-night who will not do his utmost, under all circumstances, to further the object which the Department has in view, and that is, the advancement of the Agricultural prosperity of these colonies. (Cheers). With these remarks I beg to propose "The health of Dr. Morris and the success of the Imperial Department of Agriculture in the West Indies." (Cheers).

The toast was drunk with the utmost enthusiasm.

Dr. MORRIS, in responding, said: I am exceedingly obliged to Your Excellency for the kind way in which you have proposed the toast of "success to the Department of Agriculture," and coupled with it my name. I have received since my arrival in the West Indies the very cordial support of a large company of workers engaged in their several and responsible duties in various parts of the West Indies. The labour connected with making arrangements for this conference has been considerable, but the presence and co-operation of so many able and eminent authorities in Agriculture, in Education, and in the allied sciences of Botany and Chemistry has been to me a source of great pleasure and encouragement. I am charged with duties which have been described as most onerous and responsible, but as long as I receive the cordial support of those associated with me in the work, I have no fear of the result. I can say truly that I have received that support, and any success that has resulted, so far, is due largely to those whom I see around me to-night, and others who have joined in this work. Matters had been drifting so long in the West Indies that the situation had become most acute. The Royal Commissioners made their recommendations, and those adopted by Parliament we are now endeavouring to carry out. We shall have to work for many years, and to contend with innumerable difficulties, but I feel satisfied that by the aid of those associated with us an enormous amount of good will be done, and the foundation laid for that prosperity which I believe will be of lasting benefit to these colonies. (Cheers). I again thank you for the very kind way in which you have received the toast of my health, and I assure you that I shall be happy, at all times, to be of service to you. (Cheers).

Sir CONRAD REEVES: I rise to propose a toast which I am sure will be drunk with the same enthusiasm as you have drunk the toasts which have gone before, and that is "The health, long life and prosperity of the Representatives from the several colonies" who have come here to meet Dr. Morris and to go into conference upon matters affecting our common interest. (Cheers). In proposing the health of these gentlemen I beg to couple with the toast the names of the Rev. Canon Simms of Jamaica, and Mr. A. P. Cowley of Antigua. I had the pleasure of attending the Conference to-day, and of listening to that able inaugural speech which was delivered by my friend Dr. Morris. I listened to it with the greatest admiration. I beg to propose the health, long life and prosperity of the Representatives of the several colonies, with special reference to the gentlemen whom I have named. (Cheers). The toast was drunk with enthusiasm.

The Rev. CANON SIMMS, in responding, said: As a member of the Conference I can only express our appreciation of the kindness and hospitality we received last year, and again this year in this island, and our hearty interest in the work which is being done by the Imperial Department of Agriculture. We hope that the work will go on and prosper. (Cheers.)

Mr. A. P. COWLEY: It is customary to express pleasure when one rises to respond to a toast. At the same time it is hardly a pleasure to be called upon unexpectedly to make a speech. (Laughter). I feel honoured by being included in the toast so ably and kindly proposed by the Chief Justice. I can fully state in behalf of the Antigua Agricultural Society to which I belong, that we shall work most loyally with Dr. Morris and his Department for the good, not only of Antigua, but of the West Indies as a whole. I cannot help expressing the hope that at this particular time when a crisis has arisen in the affairs of Antigua—a crisis which we, as an island, have never had to face before—that the Imperial Department of Agriculture, with Dr. Morris at the head, will do its utmost to represent our condition and obtain for us the aid we so much need to establish Central Factories. It was suggested at the last meeting of our Agricultural Society, that it might be advisable to send delegates from Antigua and Barbados to place our case before the Secretary of State for the Colonies. I do not know if the scheme is practicable: or whether Barbados could see its way to join in it. In any case we would be thankful for assistance from the Imperial Department of Agriculture. If the obstacles to Central Factories said to exist, but of which we know nothing, were removed, Antigua would be again flourishing and prosperous. I thank you on behalf of the Antigua Society for the honour conferred on me, and I again express the conviction that our Society will do all in its power to aid in the work of the Agricultural Department. (cheers)

The party then separated.

List of Staffs of Colonial Establishments.

BARBADOS.

Botanic Station.

Superintendent	J. R. BOVELL, F.L.S., F.C.S.
Asst. Superintendent ..	C. E. STOUTE.

Sugar Cane Experiments.

Chemist-in-charge ..	Professor J. P. D'ALBUQUERQUE M.A., F.I.C., F.C.S.
Laboratory Assistant ..	D. E. SEALE.
Pupil Assistant	V. B. BROWNE.
Agricultural Sup'dent .	J. R. BOVELL, F.L.S., F.C.S.
Assistant do. ...	W. C. SMITH.
Junior do. ..	L. M. COX.

Lecturer in Agricultural Science .. ALBERT HOWARD, B.A., A.R.C.S., F.C.S.

TOBAGO.

Botanic Station.

Superintendent	J. H. HART, F.L.S.
Curator	HENRY MILLEN.
Cacao Instructor . .	W. C. CAINES.

GRENADA.

Botanic Station.

Curator	W. C. BROADWAY.
Foreman	A. W. DOWERS.

ST. VINCENT.

Botanic Station.

Curator	HENRY POWELL.
Agricultural Instructor...	M. MCNEILL.
Foreman	JOSEPH B. DOPWELL.

Agricultural School.

Officer-in-charge... ...	———

ST. LUCIA.

Botanic Station.

Curator	J. C. MOORE.
Agricultural Instructor ..	GEORGE S. HUDSON.

Agricultural School.

Officer-in-charge... ...	———

DOMINICA.

Botanic Station.

Curator ... ... JOSEPH JONES.
Agricultural Instructor... DAVID TANNOCK.
Foreman ... . J. F. BAPTISTE.

Agricultural School.

Officer-in-charge ... ... ———

MONTSERRAT.

Agricultural Instructor... A. J. JORDAN.

ANTIGUA.

Botanic Station.

Curator ... ... W. N. SANDS.
Foreman .. . .. A. S. ARCHER.

Sugar Cane Experiments.

Chemist-in-charge ... FRANCIS WATTS, F.I.C., F.C.S.
Agricultural Sup'dent F. R. SHEPHERD.

ST. KITTS-NEVIS.

Botanic Station.

Curator ... ... WILLIAM LUNT.
Foreman . ... JOSEPH WADE.

Sugar Cane Experiments.

Chemist-in-charge ... FRANCIS WATTS, F.I.C., F.C.S.
Agricultural Sup'dent .. WILLIAM LUNT.

Agricultural School.

Officer-in-charge . ... ———

VIRGIN ISLANDS.

Agricultural Instructor.. ———

BAHAMAS.

Botanic Station.

Curator ... ... ———

BRITISH HONDURAS.

Botanic Station.

Curator .. .. EUGENE CAMPBELL.

JAMAICA.

Department of Public Gardens and Plantations.

Director	WILLIAM FAWCETT, B.Sc., F.L.S.
Hope Gardens—	
Superintendent ...	WILLIAM CRADWICK.
Asst. Superintendent	THOMAS J. HARRIS.
Castleton Garden—	
Superintendent ...	WILLIAM J. THOMPSON.
Cinchona (Hill Garden)	
Superintendent ...	WILLIAM HARRIS.
Kingston Parade Garden –	
Superintendent ...	JOHN CAMPBELL.
King's House Garden	
Asst. Superintendent	
Bath	
Overseer	A. H. GROVES.
Lecturer in Agricultural Science	W. R. BUTTENSHAW, M.A., B.Sc.

BRITISH GUIANA.

Botanic Gardens.

Georgetown	
Superintendent and Government Botanist	GEORGE S. JENMAN, F.L.S.
Head Gardener .	JOHN F. WABY.
Second do. ...	———
Head Gardener ... (Promenade Garden)	WILLIAM JACKSON.
Berbice—	
Keeper	RICHARD HUNT.
Sugar Cane Experiments.	
Chemist-in-charge .	PROFESSOR HARRISON, M.A. F.I.C., F.G.S., F.C.S.
Botanist-in-charge ...	G. S. JENMAN, F.L.S.
Agricultural Assistant ...	ROBERT WARD.

TRINIDAD.

Royal Botanic Gardens.

Superintendent	JOHN H. HART, F.L.S.
Asst. Superintendent ...	WILLIAM LESLIE.
Sugar Cane Experiments.	
Botanist-in-charge ...	J. H. HART, F.L.S.

V. GALE

Printer to the Government of Barbados

CONTENTS.

AGRICULTURAL CONFERENCE, 1900.

(Continued.)

EDUCATIONAL.

TEACHING AGRICULTURE IN HIGH SCHOOLS AND COLLEGES.

BY HORACE DEIGHTON, M.A., F.R.A.S.,

Head Master of Harrison College, Barbados.

Agricultural Science has been taught at Harrison College for some time, but the resources of the College did not admit of this being done in a perfectly satisfactory way, the time at the disposal of the masters who conducted the Science Department being inadequate for the purpose. When it was proposed to me that additional aid might be given by the Imperial Department of Agriculture, I had to consider what change could be made in the curriculum of the College, which, whilst giving full scope to the teaching of Agriculture to those boys for whom such a course was desired. would not injuriously affect the general education given at the College. As I had always been of opinion that it would be an advantage to education to have elementary science systematically taught in our lower forms, I gladly welcomed the proposal. I mention this because, had I thought for one moment that the change in the curriculum which would be necessitated, would interfere with the general education given at the College, I should have considered it my bounden duty to decline the offered help. My firm opinion, on the contrary, is that educationally we shall be great gainers.

This is not the place to discuss the question of the position which science should occupy in a school curriculum. But to justify my position that the systematic teaching of science in the lower forms is a gain to education I may add that "educate" means to "draw out" and not "stuff in": in other words Education(and I am necessarily limiting the term to intellectual educa-

tion) is the discipline of the intellect, the training of the mind, and not an attempt to cram the memory with facts. Now, as a mental discipline, science possesses this special value, that it not only appeals to the reasoning faculties, but also—through the experiments which necessarily form an important part of every science course—cultivates the powers of observation.

At the beginning of the third term of last year, with the aid of an Imperial Grant recommended by Dr. Morris, Mr. Albert Howard, B.A., F.C.S., was appointed Lecturer in Agricultural Science at Harrison College, and the teaching of Chemistry was begun in earnest in the first, second, third and lower fourth forms: two hours a week in each of these forms being allotted to the subject. It is early yet to gauge the results accurately; but I can say this that in every form there are boys who show themselves interested in the work, and Professor d'Albuquerque tells me that he was more than satisfied with the general results of the examination, which he himself conducted at the end of the term. No doubt there are boys in each form who take little or no interest in the work; but the same may be said of every subject: *e.g.*, has not every one who has had to teach Euclid to beginners found immense difficulty at first in getting the majority of the boys to take any interest in the work? Have they not, on the contrary, shown a marked distaste for it? But nobody would venture to say that therefore Geometry ought not to be taught. "It is a very laudable effort" says John Stuart Mill, "to render as much as possible of what the young are required to learn easy and interesting to them. But when this principle is pushed to the length of not requiring them to learn anything but what has been made easy and interesting, one of the chief objects of education is sacrificed."

This elementary course affects two classes of boys: (1) those who do not intend to continue the study of science, and (2) those who do intend to do so. In the case of a boy of the first class the course will prove a valuable intellectual training, and it will be his own fault if he is not able to take an intelligent interest in many scientific subjects which otherwise would be quite incomprehensible to him. Considering how largely and increasingly the practical applications of science enter into every-day life, ought not some knowledge of science to be now considered a necessary part of a liberal education? The advantages to a boy of the second class are sufficiently evident; he will be able to attack his new work well equipped for the struggle.

The study of science as a separate branch of school work begins in the upper fourth form. When a boy, who intends to take up science, reaches this form, he drops Greek and Latin and devotes the time thus liberated to the study of science. The particular form at which this divergence should occur has been carefully considered by me. All authorities are unanimous in insisting that a sound general education must be acquired before any special work is attacked. It may therefore appear too early to allow a boy to specialise when in the upper fourth form: and I should myself prefer putting it off till he reaches the fifth form; but I believe that local conditions, for

the present at least, require the earlier period to be adopted Dr. Morris has supplemented the appointment of a Lecturer in Agricultural Science by instituting Exhibitions to be held by boys from the country districts who are thereby pledged to become Agriculturists. At present there are five such exhibitioners at Harrison College. I believe this step to be as wise as it is liberal; probably, especially valuable as a sort of pioneer movement leading the way in which it is hoped that many will follow.

I am aware that there are many who regard this educational movement as likely to prove of little value. I think this is principally because the benefits to be derived from it cannot be immediate and must be very gradual. The problem before us is this—granting that there is room for improvement in the cultivation of the sugar-cane, on which the life of this island depends, how is this improvement to be brought about except by gradually placing the charge of the estates in the hands of men who have been scientifically trained for that very purpose? All experts tell us that Practice must not be divorced from Theory, but that all practical work ought to be based on theoretic knowledge. The wise man is he who learns by the experience of others. If we in Barbados are willing to learn by the experience of others, we shall certainly avail ourselves to the utmost of the great advantages which the foresight of Dr. Morris and the liberality of the Home Government have placed so easily within our reach.

I have explained shortly the arrangements made at Harrison College for the teaching of Science. I am confident that with the additional help which has been afforded us we shall be able to turn out scientific agriculturists just as we have turned out successful classical and mathematical scholars; and that the slight change which has been made in our curriculum, so far from interfering with the advance of those boys who do not eventually take up the study of science, will educationally be a distinct advantage to them. But if we are to be as successful in Agriculture as in classics and mathematics, we must work under similar conditions—the boys must come to us when quite young.

DISCUSSION.

Rev. CANON SIMMS (University College, Jamaica): There can be no doubt that Mr. Deighton's paper describes the only way in which it is possible for our High Schools and Colleges to take part in this work: namely, the teaching of elementary science in the lower forms, and then gradually extending it as boys reach the higher forms. I would, however, suggest that boys should specialise in the fifth form instead of the upper fourth. The paper requires little or no criticism. Every one must agree with Mr. Deighton that, apart from any value it may have on the educational side, the teaching of elementary science in these days is an absolute necessity. The boys who are going to take up agricultural work must specialise in the

science of agriculture. Technical agriculture I should regard as the work of post-school days and not a work of school days. In the last two or three years of his school life the boy should lay the scientific foundation on which technical agriculture could be built. That is the way in which good work could be done. We must first of all overcome many difficulties—difficulties arising from our slender staff, difficulties arising from the over-crowded condition of our time table, and difficulties arising from the fact that our more intelligent boys at present chiefly turn their attention to University requirements and conditions. I find few of the sons of planters and overseers in Jamaica make up their minds to go in for agriculture. The fact is, the planter tells his son that sugar does not pay, and the son naturally wants to take up something else that does pay. The only way of meeting difficulties of this kind is that so clearly indicated by Mr. Deighton.

Mr. J. A. POTBURY (Queen's College, British Guiana): All the West Indies naturally look to Harrison College for a lead in educational matters. We in British Guiana have done so for a long time. But Mr. Deighton during the past twelve months has enjoyed the advantage which the Colleges in other colonies so far have not had, that is, a supplemented staff. I should be very glad if the Imperial Department would similarly aid us in the matter. Given a staff, we are quite prepared to take up the teaching of scientific agriculture.

Rev. W. CAROLL (St. Mary's College, Trinidad): I regret to learn that my criticism last year on this subject was considered to some extent a destructive one. However, I believe it is well to see both sides of a question. It is not by ignoring our difficulties that we can surmount them. And that there are difficulties in the way of introducing the teaching of agriculture into our secondary schools I think will be pretty generally admitted. I agree with Canon Simms and the other gentlemen who have spoken as to the nature of these difficulties. First, it must be borne in mind that in our secondary schools the system of education that has existed and does exist, is and has been classical and literary rather than scientific; and so far at least, every attempt that has been made to introduce anything else has failed. Mr. Deighton and the leading educational authorities in these colonies have given us to understand that the boys should not be allowed to specialise too early. Now I think the best thing is to fix the age at which a boy should branch off to special studies, say at 17 or 18 years, and then, only when he has passed through a regular course in the ordinary subjects taught in our secondary schools. Then it becomes a question how far agricultural instruction is likely to succeed by grafting it on to our present system. It would be very unwise to overcrowd our time table. As far as my experience goes our boys are not very favourably disposed to agricultural studies. It is true that hitherto they have not had a favourable opportunity of manifesting their appreciation, but where they have had such opportunity they have not availed themselves of it to the extent one would expect. My experience of the College of which I have charge is this: that within the last three years as many as thirty young men left

us to continue or complete their studies in Europe, many of them the sons of planters and agriculturists - sons of men whose whole life was associated with agricultural pursuits; some of them went to England, some to France, some to Germany. Not a single one has so far offered to take up a course of agricultural instruction. There is a reason for it, and it is this: the impossibility of a young man making a living out of agricultural pursuits. That is at the root of our difficulty. Given that a young man could reach the same success in life as an agriculturist that he would in other professions, I am of opinion that trained agriculturists would be forthcoming. These are the points that suggest themselves to me; but in stating them I wish it to be understood that I do not oppose the teaching of agriculture in our Secondary schools. Furthermore, I am of opinion that the Imperial Department of Agriculture is endeavouring to overcome the difficulties I have indicated, and it is right that it should have the sympathy, co-operation and active support of every one in the West Indies. We came last year looking for light. We saw a glimmer then. Having heard Mr. Deighton's very explicit paper to-day, I begin to think we have streaks of dawn. I hope that when next we meet we shall be in full light, and in a position to make agricultural teaching in secondary schools the success which it deserves to be.

The PRESIDENT: Mr. Burton, the Head Master of Combermere School, Barbados, has asked to be allowed to address a few words on the subject now before the Conference.

Mr. G. B. R. BURTON: I am of opinion we should start to teach agricultural science in the second grade schools in the West Indies for the following reasons: the majority of boys attending these schools will in time be engaged in agricultural pursuits as managers and book-keepers, and through them we would gradually reach the lower classes that is, the labourers on the estates. I do not speak specially of the Combermere school because most of the pupils there will probably enter commercial life. Arrangements might, however, be made for the small number of our pupils intended for agricultural pursuits, to attend the agricultural classes at the Government Laboratory which happens to be quite near to our school. In extending agricultural education to second grade schools it is necessary to avoid two mistakes: (1) the teaching must not be given at so-called centres classes will have to be formed at each school; (2) it is necessary that more than one lecture be given per week at each school, otherwise little good will be done. I may add that we shall never get agricultural science earnestly taken up until we place it on an equal footing with other subjects and give the boys equal attention and encouragement.

TEACHING AGRICULTURE IN ELEMENTARY SCHOOLS.

BY THE REV. J. E. REECE, M.A.,

Inspector of Schools, Barbados.

I have been asked to give a short account of the recent effort made in this Island by the Imperial Department of Agriculture to give instruction and a measure of practical training to some of the teachers of our Elementary Schools. Also, to suggest how the work may be continued in future years.

About the middle of August last year a circular was sent by the Education Board to each supervising minister stating that a course of lectures on Agricultural Science would be given during the September vacation, and asking that the names of those teachers who were willing to attend should be sent in. About 70 teachers volunteered, but as it was impossible to accommodate so large a number at once it was decided to select 46 of the teachers who were in charge of Primary and Combined Schools to attend. In consequence of the absence of Dr. Morris from the Island the Very Rev. The Dean of St Michael, a member of the Education Board, gave the opening address. Mr. R. Radclyffe Hall, the Assistant Professor of Chemistry, delivered eight lectures. The course comprised life and the elementary chemistry of it: plants, their nature and work; the nature, structure and functions of roots; stems, leaves and flowers and the cultivation and care of plants.

Mr. J. R. Bovell, the Superintendent of the Botanic Station, gave demonstrations on practical horticulture on four afternoons, and on two other afternoons conducted the teachers over the gardens at Government House and Queen's House. The teachers were most regular in their attendance although many of them daily made a journey of over twenty miles. Several teachers have informed me that they considered Mr. Hall's lectures most interesting and instructive, and that they learned many things from Mr. Bovell's demonstrations which would be of great value to them in giving instruction to their pupils. An examination was held by each lecturer on the subject matter of the lectures. Thirty teachers attended this examination. The papers of nine of these were considered of sufficient merit to entitle the writers of them to be placed in the first rank. I have every reason to believe that the teachers who attended these lectures derived much good from them, and they will doubtless get more good from a similar course in the future. What has been done can only be regarded as a beginning: and I would venture to suggest that those teachers (whether teachers of Primary Schools or Infant Schools) who are interested in agricultural pursuits should be invited to attend a course of lectures to be delivered, say on the third Saturday in each month, with three or four extra lectures given during the Whitsuntide or September vacation (or both, if deemed necessary) and followed by an examination at the end of the year. Another course of lectures of a more elementary character

might be arranged for on the fourth Saturday in each month, which assistant teachers and pupil teachers might be required to attend, and at their annual examination questions might be set on the subjects in which they had thus received instruction.

Then arises the question: What can be done to give regular and intelligent instruction in this subject to the children in our Elementary Schools? I have proposed to the Education Board that they should allow the teachers who gained a certain number of marks in the examination held by Messrs. Hall and Bovell to prepare at once their pupils for examination in Blackie's Tropical Readers, and to grant a premium for each scholar who passes this examination successfully. The smaller book would be used by children in the fourth standard and the larger book by those in the higher standards. In the lower standards much useful information could be given by means of object lessons carefully selected, and intelligently taught. These in good hands would brighten school life and interest the children, but too often they are nothing but bare recitals of facts, and little is done to train the faculty of observation. It may also be possible to do something in the way of growing plants in pots or boxes; and in this connection it has been suggested to me by one of our teachers that prizes might be offered at one of our annual Exhibitions for plants grown in pots or boxes by our school children. As time goes on it may be possible to start a school garden here and there where a spot of land near the school house can be obtained: and these plots may be inspected by officers of the Agricultural Department, and prizes awarded. This no doubt will be a work of time, and it is right that it should be so. No greater mistake could be made than to force this matter on those who are unwilling to enter heartily into the scheme. Our motto in this case must be "*festina lente*." By the last issued report of the Committee of Council on Education (England and Wales), I find that in 1895 only one school out of the 19,739 inspected by Her Majesty's Inspectors of Schools obtained a grant for the practical teaching of cottage gardening: in the following year 42 schools received the grant, in 1897, 72 schools and last year 84. In the same publication I find in the general report of one of Her Majesty's Chief Inspectors on the Schools in the Welsh Division the following remarks "A great part of Wales is agricul-"tural, and the people gain their livelihood by farming. It "might naturally have been thought that in many rural schools "the elder boys would have received instruction in cottage "gardening, just as in many country villages, especially in "Carnarvonshire, their sisters have lessons in cookery. Yet "this subject practically receives no attention, and only 31 "boys throughout the length and breadth of Wales received "last year the cottage gardening grant. To anybody who has "seen the zest with which boys enter into such a congenial "occupation as outdoor work, and the stimulus which it gives "to other studies, it seems strange that this should be the "case."

The time has arrived when it is absolutely necessary that elementary education should be made more practical; and I

feel sure that these West Indian Colonies will do their utmost, with the limited means at their disposal, to make it so. There has been very little attempt made in the past to draw out and train the faculties of children. Our system must be remodelled so as to draw out these faculties. "In too many cases" (to quote from a paper by Mr. F. J. Lloyd) "the sole object of education has been to cram a certain number of useless and disconnected facts, or pseudo-facts, into what is termed the brain. Teachers recognised one faculty and one only, viz., memory; and to train this one faculty to the neglect of every other has been the sole object of education for ages past, and remains so mainly to the present day. It has entirely neglected to develop manual skill, it has neglected to draw out or cultivate any mental faculty save memory, and even for this purpose has utilised subjects, the recollection of which would in no wise benefit the future farmer. But far worse than this, it has neglected the most valuable of nature's gifts to all of us, the strongest natural faculty we possess, observation. What is the most striking faculty possessed by a child from three to six years of age? The power of observation. Watch that same child between the ages of thirteen and sixteen, and the power, though at times manifesting itself, is gradually becoming dormant, partly because it has not been cultivated, partly from its constant suppression by the ignorance and heedlessness of those who surround the child. Ten years later the faculty is practically non-existent, lost from neglect of use, as a singer may lose the power of song, or a musician the power of execution. The difficulty now found in improving Agricultural Education depends greatly upon this failure of the past." Be ours the task, as far as lies in our power, to try and remedy this defect in our Educational systems in the West Indies.

DISCUSSION.

The PRESIDENT: The Lectures so successfully given at Barbados and St. Lucia will shortly be extended to Grenada, St. Vincent and Dominica. Great interest has been taken in these lectures in every part of the West Indies. It is evident that we are working on right lines. We have among us to-day leading educational authorities whose counsel based on long experience we would gladly welcome. In Jamaica, for instance, the vote for Elementary Education amounts to about £60,000 yearly. There are in all about 900 teachers. Strenuous efforts are being made to adapt the educational system in that island to the requirements of the people and on lines very similar to those advocated by the Imperial Department of Agriculture. As Representative of Jamaica we have here the Acting-Superintending Inspector of Schools, Mr. George Hicks, who is one of the most earnest educationists in the West Indies. I would ask Mr. Hicks to be kind enough to open the discussion following Mr. Reece's paper.

Mr. HICKS: The interesting and useful paper just read is full of encouragement to those about to undertake similar

work. The systematic instruction of the teachers is of course essential before they can embark on the instruction of their pupils. Provision was made for agricultural instruction in the Jamaica elementary schools and special grants offered, but without accomplishing very much. We now propose to make such instruction an integral part of the curriculum. We are liable to fall into a mistake in introducing agricultural education into the elementary schools in the West Indies. Statements have been made that country boys prefer a town life and clerical work to a country life and tilling the soil. But this is not peculiar to the West Indies. It appears to be universal. In France what we know as the "French scheme" of agricultural instruction has been introduced for the express purpose of preventing the French country boys from yielding to the tendency of drifting into the towns and neglecting the cultivation of the soil. As in France, so in America; leading educationists there also are seeking to counteract the same tendency.

Dr. MORRIS:--In European countries and in America there are factories and other means of employment in towns to attract the people. Here we have none.

Mr. HICKS: Because that is so, our problem is not so difficult. The boys here, forsaking the soil, drift into towns and if they find no employment there they drift back again to engage unwillingly in agricultural work. Our aim should be to equip them for such work and enable them to live comfortably by it. It is now believed, and I am satisfied the belief is well founded, that education can be given on wiser and more extended lines than formerly and that the country boy so educated will find country life both remunerative and attractive. It is currently believed that there is on the part of the people of the West Indies an aversion to manual labour. We are liable, I think, to give this too large an interpretation. "Little labour, little gains" is quoted by our President. I would add "The greatest gain with the least labour" as the universal rule. The aversion to manual labour is, after all, only a desire for greater gain with less labour. When increase of gain is offered the manual labour is forthcoming This has been fully proved everywhere in the West Indies. I believe if we base our educational efforts upon the general truth that the people in these colonies are like other people, that they have essentially the same desires and are actuated by the same motives we shall be on safe ground. It is fortunate that the proposed agricultural instruction which seems to be urgently needed in the West Indies, is also that which is best from the educational standpoint. The Imperial Department of Agriculture is therefore promoting educational methods in the best interests of all. The new lines of education, the hand and eye training, the training of the powers of observation, the learning to see things and to do things, are I believe truer lines, upon which, generally speaking, a more valuable education will be gained. Our attitude should be not that of standing aloof and offering the tillers of the soil that which is for them and not for us, but as offering what we share with them—that which is best for them and best for all. The eyes of the country child should be

unsealed. He should be made to see the beauties and wonders that lie about his feet and are to be found in profusion all around him. A sympathetic, skilful teacher will invest rural life with an interest that will attract and fascinate. The life that was monotonous, dull, insipid and purely mechanical, will be changed into one full of interest; and with this there will be gained a discipline of the mind, a development of intellectual power which are prominent aims of all true education. The new knowledge and skill will be to the country boy as a new tool, the possession of a new power, and, he will be eager to make use of it. What is done on a small scale in a corner of the school plot or in the box-garden, will be reproduced at home on a larger scale and with added interest. It will be his delight to show what he can do and the useful results of his doing. He will find use for his knowledge of Reading, Writing and Arithmetic in connection with his observations and experiments in the study and mastery of some of the secrets of nature. He will have a desire to read; and, if we are wise, we shall see that he has opportunity by providing the school with a suitable library, and some of the books specially applicable to country life. *

The educationists of France and America are zealously endeavouring to make rural life more attractive, and I feel sure that they will find this possible, and also that we, moving upon like lines, will find it to be possible in the West Indies. The Imperial Department of Agriculture will certainly accomplish much in the efforts now put forth to make rural life more interesting and more profitable, and therefore more attractive. I am sure that we who are engaged in educational work will most heartily co-operate with the Imperial Department of Agriculture in its present effort to introduce a wise and feasible degree of agricultural instruction into the elementary schools of the West Indies.

Mr. W. Blair (Inspector of Schools, British Guiana): A few days after my arrival in British Guiana I received a letter from the Government Secretary asking me to submit a Code of Rules and Regulations awarding special grants to Mission Schools for Aboriginal Indians, and to schools in remote and sparsely populated localities. I will not take up your time in giving you the details of these rules, but it appeared to me that having had some experience of Agricultural and Technical Schools in the Island of Ceylon I could at the same time prepare a Code for Agricultural and Industrial Schools for British Guiana, and I had the satisfaction of seeing my proposals adopted by the Governor and the Court of Policy, and the Combined Court passed a vote of $1,500.

I divided the Schools into 4 classes A, B, C, D.

The following regulations were adopted: -

(1) Industrial Schools in which technical instruction is given shall be classed as "D" Schools.

(2) An application for a grant-in-aid to an Industrial

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* Note added:—Some schools in Jamaica now have Libraries, mainly through the personal efforts of Mr. Hicks. There is a proposal before the Government to assist the formation of School Libraries by the offer of a grant to defray one-half the total cost. [Ed. W.I.B.]

School will be entertained on the following conditions: - *(a)* that the school shall teach agriculture or a trade or trades approved by the Inspector of Schools: *(b)* that the school shall be sufficiently provided with appliances for elementary instruction in agriculture or in the trade or trades to which the school is devoted: and *(c)* that the master or mistress appointed to teach agriculture or the trade or trades is duly qualified.

(3) The Manager of a "D" School shall receive in addition to the general grants payable under No. 12 *(a)*, *(b)*, and *(c)* of the Education Regulations, 1890, the sum of \$7·50 for each pupil, being over 12 and under 17 years of age, who may be certified to have been in attendance for not less than 100 days, and to have received daily not less than two hours' instruction in agriculture or in the workshop and who is able to work at his trade to the satisfaction of the Inspector of Schools: provided that the grant to any single "D" School shall not exceed the sum of \$200 (£41. 13. 4)

(4) The number of "D" Schools shall not exceed 10.

The first to ask for a grant were the Nuns of the Ursuline Convent, for the establishment of a school laundry which has been an unqualified success, and it is impossible to visit that institution without admiring the skill and dexterity with which young girls between the ages of 12 and 17 years wash, starch and iron ladies under clothes of every sort and description, and under the direction of the Nuns the finest altar linen. Without the Government Grant it more than pays its way, and if the Government Grant were withdrawn to-morrow, which it will not be, the School would be carried on just the same. Lady Sendall visited the laundry a fortnight ago and saw the girls at work, and spoke of their performance in terms of the highest commendation.

A tailors' shop was started in Georgetown by Canon Josá in connexion with Christ Church School which for the last 5 years has been fairly successful. A carpenters' shop at Plaisance School was opened with a flourish of trumpets, but it was never a success, and in 3 years had to be abandoned. Two Agricultural Schools, one in Demerara, East Coast, and one in Berbice, at Rose Hall, were opened but both these schools were close to sugar estates on which the boys who were inclined to work could readily find employment and earn from 6d. to 8d. a day. The more ambitious of them considered working in the fields was degrading, and they were anxious to attain what Mr. Gladstone described as the "supposed paradise of pen and ink." The parents supported their children, and the schools were hopeless failures. We have been more successful at the Roman Catholic Mission Station at Santa Rosa. I have not had an opportunity of visiting the school, but my assistant reports that it is doing a good and useful work. I am afraid that one of the causes of failures was my want of respect for the prejudices of the parents. If I had required less I should have probably achieved more.

Simultaneously with the establishment of Industrial Schools I made important changes in the Syllabus of Subjects

for Teachers' Certificates introducing Agriculture for males and Domestic Economy for females. Dr. Nicholls' work is our text book, and the Hon. B. Howell Jones, a planter of wide and varied experience, is the examiner. I have already handed to Dr. Morris copies of the Examination Questions set at the examination held last week and I shall be glad if he will give you his opinion on them. Arrangements are also being made for giving a few of our most intelligent schoolmasters a course of lectures in Chemistry and Botany. Professor Harrison has submitted the course to the Government, and we are now only waiting on the Combined Court for a vote. I am hopeful for the future, and if I am privileged to attend the Conference next year I trust that I shall be able to give you an interesting account of what we have done.

Mr. J. H. Collens (Acting-Inspector of Schools, Trinidad :) I have listened with considerable attention to the valuable paper read by Mr. Reece, and I fully endorse all that he has said. We have embarked in Trinidad on pretty well the same lines as in Barbados, and in Jamaica. I cannot however say for Trinidad what Mr. Hicks said with regard to Jamaica—that our people have no antipathy to manual labour. I am sorry to say they have: consequently, the colony finds it necessary to import a large number of East Indian labourers or it would be impossible to get all our agricultural work done. If there is an attempt to make a child in the schools do manual labour, the parents state their objections very forcibly. I agree with Mr. Hicks that if our attempts to teach agriculture in elementary schools are to be successful, the greatest possible tact must be shown by the officers concerned. We must not drive or coerce the people; above all, we must try and instil into the children's minds a love of nature, and the necessity of learning nature's methods. If we succeed in doing that, we may hope in time to turn their attention to field pursuits and to agriculture generally as a means of earning a livelihood. We must, however, proceed very cautiously. In Trinidad it has been decided that the teachers should, first of all, have a course of lectures, and in the event of their showing aptitude in teaching agriculture and passing an examination in the syllabus laid out, they are to be rewarded by receiving a bonus on the results of the examination of their schools at the end of each year. That is one encouragement: but we have another. We have made the examination the means for promotion from the third class to the second. That is an important means of influencing the teacher, because it directly touches his pocket. Then with regard to teaching in the schools, we make considerable use of Blackie's Tropical Readers. These are used as alternate reading books. I feel a deep personal interest in this subject of teaching agriculture in elementary schools. I have given considerable thought to it and I am convinced if we are to do any real good we must exercise great caution and always place the pleasantest side before the parents and the teachers. Otherwise, we shall fail.

A SKETCH OF EFFORTS TO INTRODUCE THE TEACHING OF AGRICULTURE INTO SCHOOLS IN THE LEEWARD ISLANDS.

BY F. H. WATKINS.

Late Inspector of Schools for the Leeward Islands. *

On taking up the Inspectorship of Schools in St Vincent in 1883, I was greatly impressed by finding that, like too many codes then in force in European countries, the educational system of that island was wholly based on the current impression that books were knowledge and words were ideas. The instruction was concerned with nothing but words and it bore no reference to the things themselves or to the calling which the majority of children were to pursue after leaving school. During the years I remained in St. Vincent (1883 1889), I had, owing to the reduction of the vote for elementary education and the amalgamation of the offices of Inspector and Head Master of the Grammar School, but little opportunity for extensive reforms in the system. When, in 1889, I arrived in the Leeward Islands, I found that the whole system of Elementary Education in that colony was equally vicious in plan and if not actually disastrous, at least almost profitless in effect. The highest ambition of the boys, in the majority of the upper standards on leaving school, was to find employment as junior clerks in stores or to be appointed to some minor place in the Government Service. Agricultural work was considered suitable only for children in the lower standards or for those who had never attended school at all, and it was flouted almost as a degradation The natural consequence of such a system was the gradual production of a "collars and-cuffs" generation and the almost total alienation of the more intelligent portion of the population from agricultural pursuits. As these Leeward Islands, like all other parts of the West Indies, are entirely dependent upon agriculture for their progress and prosperity, it became my first care to study how this false policy could be gradually changed.

The first step taken in this direction was the training of intelligent and well-paid teachers capable of understanding the true aim of education and of using their influence to counteract the erroneous opinions then prevalent. In a few years the government grant had been increased from £3,400 to £7.250, but this latter amount, owing to the government being compelled to retrench, has since fallen to £6,300. This, however, does not include expenses of administration and grants to training colleges. In Dominica, in 1890, only one teacher was in receipt of a salary of more than £10 a year, while, at present, only one teacher receives a salary of less than £50. The consequence has been that, whereas in the former year only 2 were trained teachers, 17 out of 19 now employed in Dominica schools have

* Note added—Mr Watkins was unable to be present at the Conference as he had just then been appointed by the Secretary of State to the Executive post of Commissioner of Montserrat. In his absence his interesting paper was taken as read. It is now published in the order in which it appeared on the Agenda. [Ed. W. I. B.]

passed through some training institution. In the same island, too. all the denominational schools have one by one been given up by the Ministers of the different denominations, and these have been replaced by government schools in central localities.

Again, it was important that education should be universal; for, so long as only a portion of the population was being educated. the glamour of book-knowledge would still continue to exercise a powerful influence especially among those not in a position to judge correctly of the true ends and aims of teaching. The "Compulsory Act of 1890" was accordingly submitted to the Federal Council and passed without a dissentient vote. This Act made provision for appointing Educational District Officers, to carry out the object of the Act, for enforcing the obligation on parents to cause their children to receive efficient instruction, for restricting the employment of children of school age. and for building schools in districts where sufficient accommodation was not already provided. In the following year, this Act was supplemented by No. 7 of 1891, which improved the existing machinery for enforcing attendance and rectified certain errors and omissions inevitable in a first experiment and detected only by the experience gained in administering the original Act.

Having thus prepared the ground by financial and legislative measures for future development, my attention was next turned to the curriculum of the elementary schools. Instruction had hitherto been entirely confined to the jejune fare of the three R's, wherein mechanical teaching by rote played an important part, without any consideration being paid to true development of the intelligence through sense-impression. While trying to improve and extend the teaching so far as book-instruction went, my chief endeavour from the earliest stages was to make the children agents of their own knowledge, and give them a taste and opportunity for learning intelligently for themselves the ground work of whatever calling they might hope to follow. For this purpose. instruction in the theory and practice of the Kindergarten was made part of the course in the Female Training College in Antigua with the view of educating the children of infant schools and of the lower standards in the primary schools according to this system. For the more advanced classes object-teaching was embodied as a compulsory subject in the Code. Teachers now have to present the children in each of the four lower standards in twelve lessons on common objects met with in the district. On the school time-table an hour a day has to appear as being devoted to these lessons. There is naturally much difficulty in making many of the teachers appreciate the educative value of these object lessons, which, if intelligently given, are a never-failing source of pleasure and interest to the children. The lessons too often are confined to a few facts contained in a text book and the children are taught to repeat a form of answer to each question, whereby the lessons become merely an exercise of memory, and the value of training the powers of observation and comparison is entirely lost. At first, children were sometimes presented in this branch without any illustrative objects being at hand. Gradually, however, improvement is being

made and many of the better teachers show an intelligent appreciation of the subject. Up to lately suitable readers on common objects to be found in these islands, were not obtainable; but this gap has now been filled so far as the middle standards are concerned by the excellent Tropical Readers, designed by the Education Board in Jamaica and published by Blackie and Son.

In the higher standards the lessons on common objects are supplemented by more advanced teaching in elementary science embracing a knowledge of the thermometer, barometer, lever, rain-gauge, and of local plants.

From the highest standard some of the more promising scholars are selected to become Pupil Teachers, and enter on a course of instruction for three years. At the end of each year an examination is held in the different subjects of the Code, and Tropical Agriculture is comprised among those which are obligatory. The text book used is the admirable work of Dr. Nicholls, ("Tropical Agriculture" MacMillan & Co.) a copy of which is placed in the hands of every Pupil Teacher, male and female. I have known instances both in Dominica and Montserrat where small proprietors have borrowed this book from the school in order to study its contents for themselves, or to have them explained by others. As a rule the pages set for the examination of Pupil Teachers are those dealing with well known economic plants and local industries. The more abstruse chapters on soils, manures, drainage operations &c., being reserved for the students at the training colleges, who are recruited from the best pupil teachers, and who, as well as the teachers, are bound to pass in theoretical tropical agriculture, in order to obtain a certificate permitting them to teach in elementary schools. It is my hope that in the near future, when the work of the Imperial Department is extended in these islands, practical agriculture will be added to the compulsory subjects.

It will be observed that, from the lowest classes to the final examination of adult teachers, an attempt has been made to frame a continuous chain of instruction aiming at the gradual development of an elementary school code which will engraft practical work in agriculture on the system hitherto in force. So far the great difficulty has been to find the means and opportunity for combining practice with theory, but I am glad to record that the establishment of the Imperial Department of Agriculture in the West Indies has given us exactly the assistance we required for realizing the object in view. In addition to the opening of Agricultural Schools at Dominica and St. Kitts where the children of small proprietors will be trained in improved agricultural methods, numerous small plots attached to schools will shortly be started in Dominica and Montserrat. Courses of lectures and practical training in the principles of agriculture are also proposed to be given annually to all the teachers in charge of schools in the Leeward Islands.

Such is a short sketch of what I have attempted to do in this Colony and though, perhaps, there may be no apparent practical gain at present, it can at least be claimed that the

seeds for future growth have been sown. Even this has not been accomplished without much discouragement, many failures and disappointments, and not a little misunderstanding and ridicule. But it is evident that the "voice in the wilderness" of ten years ago is becoming more and more the voice of the multitude.

The moment has now arrived for combined action throughout the West Indies, since a great movement like this must be supported by the energy and impulse which can alone come from many minds acting in unison. But, in the hour of hope and success, let us still remember that great care must be taken lest, as the outcome of sympathy and enthusiasm for a good object, we may be led into false paths and wreck our enterprise by too precipitate action.

I have to add with regret that, owing to being appointed to another branch of the service, I have to disassociate myself from the educational work to which I have devoted the best years of my life, but I shall always hope to be able to take an active interest in what is being done to further the best interests of these islands. It has been a source of encouragement and interest to me to know that my work has met with full recognition from the authorities at home. In acknowledging my last Annual Report the Secretary of State made, among others, the following remarks:

"In particular, I may express my entire approval of Mr. Watkins' observations as to the importance of Agricultural Education in the Leeward Islands, and the best means of promoting it. As you are aware, this subject has been, and is, receiving my most careful consideration."

SUGGESTIONS FOR A SCHEME OF AGRICULTURAL EDUCATION IN ST. LUCIA.

BY GEORGE S. HUDSON,

Agricultural Instructor, St. Lucia.

I must preface my remarks on Agricultural Education in St. Lucia by explaining that it is only within the last few months that any attempt has been made in this island to teach the principles of "the oldest profession in the world," and any recommendations and deductions that may be brought forward in this paper, do not in every case bear the hall-mark of experience. They must be regarded as embodying a tentative programme thrown out to elicit discussion and obtain a better conception of a comparatively new and many-sided question.

We are practically starting with a clean slate and it is usual under such circumstances to sketch an outline, definite or approximate, of what our ultimate aim should be. Naturally we wish in St. Lucia as elsewhere to attain agricultural prosperity; but such a definition is much too vague and gen-

eral to help us very much. To my mind the sequence of successes aimed at in agricultural education should find their goal in one definite, hoped for achievement, viz:—the largely increased exports of profitable products. This desideratum, I contend, covers in our particular case the whole scheme of agricultural advancement and prosperity, and though we may have to diverge into many side paths in pursuing this aim, we must never lose sight of the main object either when giving simple object lessons to infants, when teaching boys practical work, when advising adult agriculturists, when promoting Agricultural Shows, when issuing agricultural literature, when checking emigration or assisting immigration. In fact in all our work, that which we are striving for (the means by which a comparatively poor community can become prosperous) is to be attained by studying the wants of our richer neighbours, and supplying them with those products which promise us the greatest profits. That is the prime end in view and we shall now briefly consider the means of attaining that end.

The subject naturally divides into three parts: (1) juvenile teaching; (2) the training of boys and teachers at the Agricultural School; (3) the influences to be brought to bear on adult agriculturists. There are many other roads to the object before us, but these three are, I believe, the principal means by which a system of education can hope to contribute towards agricultural success in St. Lucia.

JUVENILE TEACHING.

Dealing first with juvenile teaching in elementary schools, I may mention (excepting one small secondary school) there are 48 primary schools in St. Lucia, numbering on their rolls over 6,000 children, of whom about 3,200 children, of an average age of say 9 years, attend daily. It is rare even in larger schools to find more than half a dozen boys of 12 years, or older; and considering the domestic conditions existing in country districts it is hardly reasonable to expect to see children of over 12 years of age at school. I cannot speak as an educational authority, but I am of opinion that the average boy of 12 years who has not to some extent mastered the three R's, will do no good by remaining longer at school. What I would recommend in St. Lucia is compulsory education between the ages of 8 and 12; but on such a weighty matter there are many here more competent than myself to give an opinion. Such then is the raw material we have to work upon. We must take it as we find it and do our best with it. Is it hopeless to teach agriculture to such young children? So far as my limited experience goes I can say distinctly. it is not hopeless. No one contends that children under 12 years cannot learn writing and arithmetic, yet to my mind these two studies are infinitely more complex and uninteresting than a course of object lessons, with experiments &c., in the elements of agriculture. The children in the St. Lucia schools think so too if one can judge from their attitude and brightness. I am convinced we shall have no difficulty with the children, but I am also convinced that unless the work of agricultural education in ele-

mentary schools is proceeded with on very tactful lines we shall have difficulties with the parents. It is not unnatural that a protest should be made against attempting to teach very young children too much agriculture. That was my own view on starting my duties and I must confess that I felt my opportunities for usefulness had been greatly impaired when Dr. Morris decided against attempting to teach practical agriculture in the St. Lucia schools. A little more experience has taught me that Dr. Morris was perfectly right, and had I followed the bent of my own inclination by allowing the school teachers to commence garden plots and experimental work at the outset, we should have come into immediate conflict with the parents, who would in many instances have removed their children from the schools. The parents' view of the matter is not one of entire unreasonableness. They say: "We send our children to school at some sacrifice to ourselves, in order that they may learn to read, write and cypher: we do not object to their being taught agriculture, but we contend that we ourselves, being practical agriculturists, know a great deal more about it than the school teacher does." Now it is not to be denied that from the point of practical work the parent could, in some cases, substantiate his case against the teacher, but it is principally in the direction of sound theoretical teaching that we can demonstrate to the parent the teacher's ability to discover to his son interesting points about plants of which he (the parent) has not the faintest conception, thus gaining the parent's confidence and strengthening the teacher's position. Even when this has been done a great deal of caution in employing the children's labour in experimental school plots will be necessary. The parents will be very quick to resent any arduous labour imposed on their children without payment or recompense, and it may, I think, be laid down as a cardinal rule that no school teacher shall benefit in any way from the produce grown on experimental school plots.

Book I of Blackie's Tropical Readers is now the text book in use among such children as can read. Three hours per week are being devoted, as a commencement, to agricultural education. One-half of this time will be taken up in reading and discussing Blackie's Reader and the other half to interesting object-lessons in plant life. The New Code of Regulations now under the consideration of the Government of St. Lucia, proposes to offer grants to schools to the extent of 10/- per annum for each pupil who successfully completes a course of practical agriculture with the help of school plots. The teachers are naturally anxious to earn this money. I may add here a few words regarding the necessity for a really suitable text book for use in the upper classes. In such a book all attempts at botanical teaching should be eliminated, while at the same time prominence should be accorded to scientific data in some degree corresponding to their relative importance. A second part of the same work should contain full cultural and curing details of those crops most suitable to the West Indies, the whole being couched in the simplest language.

AGRICULTURAL SCHOOLS.

Besides inculcating correct agricultural ideas in the minds

of the children, the system here suggested promises to bring into prominence the more intelligent boys from whom I look for the material to leaven the whole agricultural mass. This leads me to the subject of an Agricultural School and Experiment Station, which we hope shortly to see established in St. Lucia in connection with the Imperial Department of Agriculture. The usefulness of an Agricultural School might be threefold :—(a) as a means of turning out skilled agriculturists; (b) for the training of Elementary School Teachers ; (c) as an experimental and sample Station.

It is now clearly understood that under no circumstances should the Agricultural School be worked as a juvenile criminal reformatory. On the contrary its advantages should be available only to boys who bring the best record from the elementary schools. I would further suggest as an inducement to this class of boy to enter the Agricultural School that eventually a free grant of 5 to 10 acres of Crown Lands might be offered by the Government to each lad who completes a five-years' course at this school, and is otherwise suitable, to afford him the means of giving practical effect to the knowledge he has acquired and at the same time demonstrate and diffuse that knowledge in his own locality. It may be that without some such advantage it will be difficult to induce parents to part with their children, say between the ages of 12 and 17, during which time their services would be lost to them. A further inducement would ensue if the Agricultural School apprentices were to find ready employment on estates as managers and overseers, and there is little doubt that such would be the case. In connection with these appointments a point occurs that will require special consideration and treatment in the training of these lads, viz: their inherent lack of moral fibre and their unreliability. These deficiencies, at the present moment, if anything, are more serious in estate employés than insufficient agricultural attainments.

As a means of training teachers of elementary schools the Agricultural School could perform valuable work. At midsummer last year all the teachers throughout the island attended a course of lectures on Botany and Agricultural Chemistry at the Botanic Station, Castries, and on my tour of inspection of the schools in November last I made a point of discussing the subject with the teachers and going over their notes with them. On the whole I was convinced that they had gained much useful information. To cover so wide a subject as Agriculture I recommend however that they should each be supplied with a thoroughly good but simple text book. I would also recommend that the course of lectures be continued and later on arrangements might be made whereby one or two teachers at a time could spend a fortnight or so every year at the Agricultural School.

Leaving the scholastic side of the proposed Agricultural School, there would be great scope for usefulness on the experimental side by cultivating new products on a commercial scale, and illustrating improved methods of cultivating products which already appear in our list of exports.

FIELD INSTRUCTION OF ADULTS.

There is no disguising the fact that in the adults we have a somewhat refractory element and no small amount of tact will be required to win their confidence. I refer more especially to the more unenterprising peasant proprietor who constitutes the largest class of St. Lucia land-owners. The farm work at the Agricultural School will not greatly appeal to this class for the members of it will not go to inspect it, nor is it likely that they can be reached by printed reports giving the results of experiments. I have been allotted the duty of starting work amongst small settlers in the Windward and Southern districts of St. Lucia by selecting experiment plots to illustrate the regeneration of unhealthy Cacao trees, the rotation of small crops for export and the introduction of new plant products. These plots will be worked with the object of showing a profit, and the results will be prominently placed before the people in each district.

I would suggest as an effective means of reaching this peasant-proprietor class that an annual Almanack, in pamphlet form similar to Bristol's Almanack (which is to be found in almost every hut in St. Lucia) should be prepared and distributed gratis, the literary contents treating mainly of agricultural subjects of local interest couched in simple language. A somewhat more ornate cover than Bristol's Almanack would add to its attractiveness and local advertisements of tools, machinery, seeds and manures might be admitted.

It is a matter of the utmost importance if we are seeking to increase the value of our exports, that the people be brought into closer touch with the conditions affecting the sale of produce, not only at the large terminal markets, but also in the local markets of the Colony. Frequently the greatest ignorance prevails as to the selling value (say in London) of produce that does not form a recognised local channel of traffic. Statistics might also be published of the fluctuations in demand and supply of fruit, cattle, provisions &c. by the help of the Market Clerk in the principal town. It is said in English country circles that "the farmer who never goes to market seldom prospers." The necessity to keep in touch with the times is one that is recognised in all prosperous planting communities. What I suggest to meet this deficiency is the preparation and distribution at frequent intervals of a full market report throughout the West Indies.

The fostering of competition in local agricultural efforts is another agency that we cannot afford to neglect. During the past year the Agricultural Society has held two Shows in St. St. Lucia under the auspices of the Imperial Department of Agriculture. As initial efforts they were highly successful. It is intended to repeat these competitions yearly, and I hope to see them extended. It is necessary at the outset that an assurance be given to the people that these Exhibitions will be continued at regular dates in order that sustained efforts may be made in the production and exhibition of superior produce. I maintain that one-half the good effect is lost when the an-

nouncement is sprung on exhibitors a few months only before the exhibition, Some degree of pride in the products of our labour is a great incentive to good work, and I advocate the extension of this system of local competitions by the Government, providing prizes for the most successful plantations of cacao, coffee, nutmegs, &c., at different ages, as a means of stimulating higher cultivation, and the starting of additional plantations.

In order to win the confidence of the people I have adopted the plan of regularly visiting estate managers and small proprietors and walking round their plantations with them in a neighbourly way. I have always met with a courteous reception, with a marked disposition to ask for and receive advice. As a result of this course of procedure I have received many invitations from proprietors to visit their properties and advise them in their difficulties. In going round the country in this way I could not fail to observe the considerable influence that the Botanic Station has exercised in the distribution of new plants, such as Liberian coffee, nutmegs, kola and many other economic subjects which ten years ago were almost unknown in St. Lucia.

OBSERVATIONS AND EXPERIMENTS TO ILLUSTRATE THE PRINCIPLES OF AGRICULTURE IN ELEMENTARY SCHOOLS.

BY THE HON'BLE WILLIAM FAWCETT, B.SC., F.L.S.,

Director of Public Gardens and Plantations, Jamaica.

At the last Conference during the discussion on the subject of teaching agricultural principles in elementary schools, the Rev. Canon Bindley sent a shock through the minds of those representing education by saying that if they wished to do any real good with the children, they should throw books to the winds.

I heartily sympathise with this expression of opinion.

The teachers should, however, be provided with some guide for their lessons in the elementary principles of agriculture. They have text books, but the danger is that with these alone, the lessons may become a mere repetition of words.

I have looked through many of the excellent text books, and primers on the subject, but have failed to find exactly what in my opinion is suitable to our circumstances in the West Indies.

The notes that follow are intended as suggestions to the teacher of the plan that he may adopt. They are quite tentative, but some are taken from well-known text-books.

The main thing that the teacher should bear in mind is to make the children observe for themselves, and deduce the

principles from their own experiments. The children should make the experiments and do everything for themselves.

Both teacher and children should make notes, and keep them for future reference.

The object of such notes is not to acquire a definite amount of special information, but to help in the formation of habits of accurately observing, and of tracing the effects of certain operations. If the teaching be carried out in this way, it will be truly educational.

GROWTH OF STEM AND ROOTS.

Germinate a bean between two pieces of damp cloth. When the root is about two inches long, put a mark with ink or other pigment at a quarter of an inch from the tip of the root, 2 or 3 more marks at equal distances higher up, and another just below the seed. Let the seedling grow on for a day or two. Measure again, and note what has happened.

Similarly mark the stem of a young seedling bean, without disturbing it in the soil, at distances of $\frac{1}{4}$ or $\frac{1}{2}$ inch. Measure the spaces *a*, *b*, *c*, &c., at intervals of 24 hours, and note them down each time Compare the measurements of the spaces between themselves each time, and observe whether there is anv difference. Compare also each space, such as *a* from day to day.

Examine any growing shoot, (one may be a bamboo,) shortly after it appears above ground. Measure the joints at intervals of 2 or 3 hours. Notice whether there is any difference in growth between the youngest joints and the older joints.

SENSITIVENESS.

Take a seed which has germinated in the fold of a damp cloth, and bury it below the surface of wet sand in a flower pot with the root pointing upwards. Keep the sand continually wet for a few days until the leaves appear, then take up the young plantlet, and notice the direction of growth of root and stem.

Grow a seedling in one corner of a bed in rather dry soil. When 3 or 4 inches high, keep the soil much damper at a point distant 3 feet from the seedling. After some days examine the direction of the root.

Grow a plant in a pot near a window, and see the curvature of stem and leaves. Turn the pot round, and observe the position again after a time.

Make a drawing of a tendril, say of a Granadilla, before it has touched a support, and again some minutes after it has touched it. Draw it again later when it has formed a spiral spring below the support. Measure the distances between support and leaves at first contact and on completion of spiral.

Observe how the Sensitive Plant or Shame Weed *(Mimosa pudica)* closes its leaves to a touch, and that it is sensitive to the flame of a burning match. Notice the position of the leaflets at night, in the early forenoon, at noon, in the afternoon and

again at night of the Sensitive plant or Shame weed and of the Guango *(Calliandra Saman)*. In this connection take two thin plates of some metal, and at noon fix one vertically and the other horizontally; touch them after a few minutes, and compare the temperatures.

Does the plant in each case benefit in any way by its response to a stimulus? Indicate the stimulus in each case.

PROPAGATION.

Take seeds from a fruit or seed-vessel that is not ripe, from one of the same kind that is perfectly ripe, also some seeds that are unusually large, some of the same kind that are unusually small, and some that have lain by for a long time. Take an equal number of each. Grow them and compare them for early germination, for vigour and for productiveness of plant when full grown.

Note if there is any advantage to be derived from early germination in the matter of weeding and also in insect pests.

Experiments with annuals, with plants of a longer life, with plants grown only for leaf, with those grown only for seed or fruit, should be carried out, and careful notes kept and comparisons made from time to time.

Sow some corn in a wet seed-bed, and others of the same kind in a seed-bed only just moist. Sow some more 1 or 2 inches below the surface, and some a foot deep in soil which has been well prepared for a seed-bed, just moist and of firm texture. Run very thin twigs or splinters of wood down to some of the seeds which are a foot below the surface. Give explanations of results.

PLOTS OF GROUND.

Dig two trenches 3 or 4 feet wide in the school garden and 9 to 12 feet long, with an interval between each of 3 feet.

Note whether there is any change in colour and texture of the earth as you dig from the top-soil into the subsoil.

Keep the soil in a heap by itself, and the subsoil in three separate and equal heaps.

Dig to such a depth, if possible, as to make the heaps of subsoil together about equal to the heap of soil.

Fill in the first trench with the soil to illustrate the value of depth of soil.

Into one half of the trench dig some cow or horse manure, taking care that the liquid part has been preserved as well as the solid.

Mix two of the heaps of subsoil thoroughly with grass or cane tops chopped fine, or even with leaves in the proportion of about one third grass and two-thirds subsoil. Add to one of these a small proportion, say one-twentieth part, of good garden soil.

Divide this trench into three equal parts. Boards or zinc roofing may be used to divide the spaces from one another, and

also, if necessary, to keep the sides from falling in. In fact it would be well to arrange so that the sides all round of each division should be permanently enclosed by the zinc, which should project 2 or 3 inches above the level of the surface.

Fill the subsoil heaps separately into the divided

If the soil should happen to be very deep, sm weathered rock may probably be obtained from some landslip by the roadside. The trenches will require fi from time to time from the proper heaps until the eart quite settled down.

By the side of this trench at an interval of say mark out three spaces equal in area to those in the tr. Dig up thoroughly, and manure one of the spaces as before, dig cow peas or other leguminous plant, into the third. T cow peas should be sown beforehand, and dug in when in flow

At an interval of 3 feet, mark out again 3 equal space and simply hoe down the weeds. Make one of these a seed-be for experiments with seeds and seedlings.

* At intervals dig 3 more beds each divided into 3 equa parts.

These 9 divisions (see opposite page) are for experiment with fertilisers to show the effect of nitrogen, phosphorus, an potash, these combined two together, the three together, alon and combined with lime, and lime alone.

The following key may be useful for purposes of referenc in regard to these plots:

N. Nitrogen.
P. Phosphorus.
K. Potash.
PK. Phosphorus and Potash.
NK. Nitrogen and Potash.
NP. Nitrogen and Phosphorus.
CaO Lime.
NPK. Nitrogen, Phosphorus and Potash.
NPK and CaO The latter with Lime.

Sow corn or other seed, or transplant, so as to have an equal number of seedlings in the various divisions.

Hoe the weeds continually in all except one of the divisions which were simply hoed.

In a town school kerosene tins with drainage-holes pierced in the bottom may be substituted.

As the corn ripens, weigh the cobs, and when all are picked, weigh the stem and leaves. Make out a tabular statement of produce from each division. Dig up carefully a few plants in each, and measure the length of the roots, and note how far they spread horizontally and vertically.

State as fully as possible the reasons for any differences observed.

TABLE shewing arrangement of plots in School Gardens (the intervening uncultivated spaces being omitted.)

Deep Soil.	Subsoil.	Soil well dug.	Soil hoed.	Soil well dug.		
alone.	alone.			N	P K	Ca O.
with manure.	with grass.	with manure	not weeded after planting.	P	N K.	N P K.
with cow peas.	with grass and soil.	with cow peas.	Seed Bed.	K	N P.	N P K. and Ca O.

PERMANENT ECONOMIC PLANTS.

Part of the School garden should be devoted to a plantation of permanent economic plants, e.g. one, or more, or all of the following: orange, cacao, coffee, nutmeg, kola, banana, grape vine. These should be planted at the proper distance from one another, and care should be taken that any of them which require shade should be provided with it beforehand.

Till the ground all through this plantation, explaining how tillage is as useful for these as for annual crops. Note besides, that by burying decaying foliage and fruit in tillage, the breeding places of many insects and of fungous pests are destroyed. It will probably be found necessary also to examine the roots, especially of orange and cacao, for grubs which injure them. If such are found, they should be kept in soil with some vegetable matter to feed on until they emerge as perfect insects. Knowing then what the perfect insect is, it can be killed whenever caught, and prevented from multiplying to such an extent as to become a plague.

Occasionally open up the ground and trace the course of one large root and all its branches. Measure length and the depth of soil occupied.

When necessary, prune but always sparingly. Write down beforehand the object aimed at in the pruning, and note the results, and whether the object has been attained. Observe the wound caused to the plant by every cut, and the facility thus created for entrance of minute fungus spores or insect pests, causing disease. Make a very smooth cut and compare with a stump left when a branch is broken off or roughly hacked. Apply tar, or lead paint to the large wounds, note down the object and the effect.

With a spray-pump apply insecticides and fungicides, as they are wanted. The spray-pump may be also used for watering.

ANIMALS IN RELATION TO CULTIVATION.

Collect horse and cattle manure, liquid as well as solid, and house it in a shed to rot The floor should be sunk to form a pit, the sides and floor of which should be of stiff clay well pressed down. Weeds, leaves &c. should be collected and thrown in with it. But any weeds &c. that are in seed, or diseased, should be burnt, as well as any that are liable to remain alive, such as the roots of grasses, and the tubers of the nut-grass; the ashes of the burnt weeds should be added to the heap. Weeds, dry grass or a little dry earth should be placed at the bottom to absorb any liquid passing through. The bones of animals and, if an animal is killed, the blood, should be added to the compost.

A pig might be kept in a sty, and the sty cleaned out every day or two into the manure shed.

Poultry in the same way may be kept in a run, so arranged that it could be moved from one place to another in the economic plantation, especially where insects are found at the roots,

When tobacco is cultivated, the value of turkeys in picking off the caterpillars can be demonstrated.

A beehive should be kept, and the work of bees in the fertilisation of flowers noted.

SOIL.

To find out something of the character of the soil, take a sample from the garden, pick out the stones, rub it down in a mortar, or bowl, and sift through muslin.

Put on one side the small stones, and decaying remains of plants which are left in the muslin.

Put the sifted soil again into the mortar, and half fill it with water. Grind the soil in the water, and then gently pour off the muddy water into a jar. Add more clean water, grind again, and pour off as before. Repeat until the water no longer becomes muddy or discoloured. The remainder at the bottom of the mortar will be seen to consist of small grains of sand.

When the muddy water has quite settled into the jar, the clear water may be poured off, and a fine sticky clay is left.

Thus the soil has been divided into coarse gravel, fine gravel, sand, clay, and the decaying remains of plants.

Observe, in the district, instances where one of these classes predominates over the other divisions, and note from the growth of plants what kind of soil suits them best.

AMOUNT OF WATER IN SOIL.

Take some soil, say 4 ounces, which is moist enough for healthy plants to grow in.

Weigh it exactly.

To find what weight of water is in the soil, heat in a water-bath for an hour or two, keeping it stirred all the time.

The water-bath can probably easily be made by a local tinsmith, on the principle of a glue-pot, in the inner case of which the soil is to be placed in a tin dish for convenience in removing it to weigh when cool.

The weight will be much less than at first, for the temperature of boiling water causes the water in the soil to evaporate without burning any part of the soil.

Put it back in the water-bath for half an hour, and weigh again. If the weight is the same as before, all the water has been driven off, and the loss of weight will show the proportion of water in the soil, 10, 15, or 20 per cent.

If a good balance can be used a much smaller amount, say an ounce of soil, would be sufficient.

If a high temperature can be used, such as that of a Bunsen burner, the amount of humus* can to some extent be estimated after driving* off all the water, by weighing before and

* The "combined water" retained by the soil is not driven off at the temperature of boiling water, but will be included with the "humus" thus determined.

after heating. Subsoil can be compared, showing very little humus, or generally none at all.

RISE OF WATER IN SOIL.

To illustrate the rise of water in the soil take 2 flower pots, fill one with sand, and the other with garden soil. The sand and soil should be first dried in an oven. Stand them in a pail with 2 or 3 inches of water and note that the soil soon becomes moist.

The particles of soil must be sufficiently close together for the water to rise.

Instead of flower-pots take two kerosene tins and put moist garden soil in each, so that their weights shall be equal. When the surface dries a little, weigh again, rake over the soil in one tin to a depth of three inches, so as to break it up and make the particles lie loosely together, and do this every 3 or 4 days. Weigh both every few days. Note that the untouched one loses weight more rapidly than the other and becomes practically dry very soon. The moisture evaporates from the surface and the water rises until it has all escaped. Whereas the tin in which the surface soil was raked, retains moisture for a considerable time. The moisture cannot rise through the loose surface soil and evaporate into the air, but is conserved in the soil below.

In periods of drought when every drop of moisture is necessary to keep plants alive, the surface soil of the garden plots should be broken up by hoe or rake, in order to prevent the loss of water by evaporation from the soil, and preserve it all for the roots of the cultivated plants. This tillage also kills the weeds which rob the plants of water, as well as of food.

If the tins are exposed to heavy dew, it will be found that the loose surface takes up much more moisture than the undisturbed soil, and so gains in moisture over the other.

Sow seeds in two small beds which have previously been well soaked with water. Now compact the surface of one by drawing a light roller over it, or by putting boards down, and pressing down with the feet. This acts in two ways; it brings the damp soil more directly in contact with the seeds so that they absorb more water and germinate quickly; it also allows the moisture to rise from below to the surface layers where the seeds are sown. As soon as the seedlings appear above ground, the surface should be raked.

Various kinds of soil have different capacities for holding water.

Take 4 flower-pots of equal size with some pieces of broken pot at the bottom of each, and put gravel into one, sand, clay, garden soil and decaying vegetable matter into the others. These should all be first thoroughly dried in the sun, and an equal weight of each used. Weigh them in the pots. Pour water very slowly into the pots until it flows freely out at the bottom. Cover the surface with pieces of oil cloth to prevent evaporation while the free water is draining off. The differ-

ences in weights before adding water, and after the drainage, show the capacity of each kind for holding water.

To illustrate the necessity for drains to carry off free water, put a flower-pot with soil in it into a pail, and pour water into the pail until it stands at the level of the surface of the soil. The soil will soon become muddy, and if the water is kept supplied in the pail, any plant growing in the pot will soon die. If however the water is poured out of the pail only leaving a couple of inches in it, the free water will drain off, and the soil will become drier, but will remain moist so long as any water is left in the pail. Drains are made at such a depth as to carry off free water from the roots.

TILLAGE.

To illustrate the effect of fine tilth, take some good clay, and mould it into a cube of convenient size, say 10 × 10 × 10 inches.

Cut out pieces of cardboard or paper, each one the size of the sides.

Calculate arithmetically the total area.

Cut the cube into two, and cut out pieces of cardboard as before, computing the area.

Cut each half into two, and do as before.

Now cut each piece into small cubical pieces, each an inch every way. Cut the cardboard, and calculate the total area again.

Instead of trying to make any more divisions, the simple calculation can be carried on of the total area resulting from each cubic inch being cut into cubes $\frac{1}{10}$ inch every way, and even $\frac{1}{100}$ inch. It is easy to show in this way, that a hard lumpy soil when converted by tillage into a finely-divided soil presents a vastly increased surface for the roots to take up food and water, for air to pass through, and for the soil to be acted on in various ways so that more plant-food becomes available.

An acre of hard soil becomes, if properly tilled, equal in value to several acres.

On the other hand if the particles are too fine, as in clay land, the interspaces are filled up, and neither air nor water will pass.

Mould a cup from clay, and note that it will hold water.

IMPROVING TEXTURE OF SOIL.

Lime and decaying vegetable matter may be added to make the texture of clay land of a better character.

ADDITION OF LIME TO A SOIL.

The effect of lime in improving the texture of clay land may be illustrated in the following way.

Shake up some lime in water.

Work up a ball of stiff clay with the lime water, and

another with rain water. The latter will remain hard on drying, while the former will fall to pieces.

ADDITION OF HUMUS.

The improvement of soil by ploughing in green crops may be illustrated both on sandy soil and clay soil by taking kerosene tins containing soils without any addition, and with chopped grass added. Experiment by growing beans in them, and noting difference in crops.

BURNING CLAY.

Take a lump of clay, heat it red hot. This alters the condition so much, that when cool it can no longer be kneaded up with water. A piece of brick which is made from clay by burning, pounded up in a mortar, allows water to pass through like sand.

Clay is sometimes improved by burning it in heaps, and then spreading and ploughing it in.

WATER IN PLANTS.

That a plant requires water, and that it absorbs by means of its roots, and that abundance of water keeps the leaves stiff, is easy of demonstration by watering the roots of one plant and with-holding water from another.

To illustrate the passage of water up from the roots to the leaves, pull up a young plant by the roots. Carefully shake off the soil, and put it in a pan containing water in which a little aniline red dye has been dissolved.

Examine the plant after 12 hours, and it will be found that all the fine veins in the leaves are stained red.

To discover through what part the water rises, take a piece of stem of green corn, the leaf of Canna or "Indian shot" with its stalk, and some woody branch, and put the ends into water in which a little aniline dye or red ink has been dissolved. After some hours cut through the pieces, and the red stain will show where the water has passed up.

Pick a leaf and put it under a glass in the sun and the glass will be dimmed with the moisture passing off from the leaf. Take a small plant growing in a flower pot, cover the soil with oil cloth to prevent evaporation from it. Put a glass over the plant, and place it in the sun. Moisture collects on the sides of the glass. Water has passed from the soil by means of the roots through the plant, and some of it has passed out and condensed on the glass. Take two leaves from a plant, place one with the under side, and the other with the upper side on a polished surface such as a looking glass, note that the surface is dimmed in different degrees. The moisture passed out through pores in the surface of the leaf which are more abundant on the lower side than on the upper side.

RESPIRATION.

To illustrate the respiration of plants—the taking in of oxygen and the giving out of carbonic acid, Soak peas or beans for a day, and half fill a wide-mouthed bottle with them; add a little water, and cork it.

After 24 hours, put a lighted match or wax taper into the bottle and it will be extinguished; the oxygen has disappeared. A small vessel of lime water lowered into the bottle becomes turbid or forms a slight precipitate; this is a test for carbonic acid.

Oxygen is also wanted by the roots. A wet soil, by keeping out the oxygen of the air, is fatal to most plants. In some plants, for instance some mangroves, portions of the roots grow up into the air in order to absorb oxygen.

CARBON.

To realise the vast amount of carbonic acid gas that is taken from the air by leaves, in order to turn its carbon into the substance or body of plants, take a small log of wood, dry it thoroughly in an oven, weigh it, and have it at once made into charcoal, weigh the charcoal. The bulk of the charcoal represents the carbon, one of the components of carbonic acid, the other component oxygen being given out again into the air. Break this piece of charcoal carefully into small pieces, and burn it in a charcoal burner, until it has quite burnt out. The ash remaining is the amount of potash, phosphates and other mineral substances taken up from the soil in solution in water by means of the roots. Weigh this and deduce the percentage of carbon and of ash. *

STARCH.

The carbon is united chemically with water, and forms starch in the green parts of leaves during daylight. Pluck about noon a leaf variegated green and white. Put it in hot alcohol until the green colour disappears, and then add some iodine. The parts which were green are coloured violet-brown, showing that they contain starch. A similar leaf picked in the early morning would show very little or no starch.

The food of plants, to be used for growth afterwards, is stored in the form of starch. When growth commences this starch is changed into a sugary material which can pass from cell to cell. Compare tuberous roots like cassava, in dry weather when ripe, and in the commencement of rainy weather, when they are beginning to shoot again. Cut a piece, and put on it some tincture of iodine. If starch be present the colour will become blue. Test it in comparison with prepared starch. Examine slices of the soft growing top of sugar cane, and test for starch.

* There is some loss of carbon in the operation of preparing the charcoal so that the percentage of carbon is really somewhat in excess of that thus calculated.

THE PROPOSED AGRICULTURAL DEPARTMENT AND AGRICULTURAL TEACHING IN JAMAICA.

BY THE REV. CANON W. SIMMS, M.A.

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During the year, since the last Conference here, we in Jamaica have had much discussion concerning the lines on which our agricultural progress is to proceed. Though the Imperial Department only touches us with a small part of the fringe of its garment, still its creation and the presence of the Imperial Commissioner in the West Indies have co-operated with other causes to force the question to the front in Jamaica as well as elsewhere. The Jamaica members of the last Conference, Messrs. Fawcett, Watts and myself, were instructed by the Government to prepare a scheme for an Experiment Station in Jamaica, and to discuss the question with Dr. Morris, for the purpose of getting advice generally, and also of seeing what prospect of help from the Imperial Department there might be. In pursuance of these instructions we sent in a full report on the 18th of February last: this report was approved by a resolution of the Legislative Council on May 30th, as laying down the lines on which such an Institution might be founded; but meanwhile the idea was started of forming a Department of Agriculture, to take this new departure under its charge as well as the existing departments, the work of which bears on agriculture. Dr. Morris and the Secretary of State were consulted, with the result that the Island Government, in November, appointed a Committee to suggest a scheme for the formation of the new Department on lines laid down broadly in a despatch from the Secretary of State. Dr. Morris promised to come to Jamaica to assist the Government and in accordance with his promise visited us at the beginning of December last.

I propose to commence my paper by giving a brief outline of the report of that Committee. It will be understood that the task before it was not to start with a clean sheet and create a new set of agricultural agencies, but to work existing agencies and officers into a more comprehensive scheme, which should also provide for needs at present unmet or only partially met. It had long been felt that the existing Botanical Department, whilst doing its own work efficiently, did not possess an organization enabling it to cover the whole field, and an attempt was made a few years ago to supplement it by the creation of an Agricultural Society, which should receive assistance from the revenue, but should be largely independent, and enable the practical sugar-planter, and pen-keeper to contribute his quota to the solution of the problem. This Society has done much valuable work; it has tackled many problems, has helped in taking practical agricultural teaching to the door of the small settler, and brought to Jamaica the first Chemist officially engaged in agricultural work in the person of Mr. Watts, whose brief stay amongst us has helped to sow much good seed from which we hope to see a crop. Mr. Watts held a somewhat anomalous position as

filling the post of Island Chemist and also that of Agricultural Chemist to the Agricultural Society. The vacancy in his office has left the Government and the Committee with a clean sheet in the chemical department.

The Committee having the task of creating a Department of Agriculture which shall make the most of these agencies, with the addition of an Experiment Station, has recommended the appointment of a Board of Agriculture having under it (i) the existing Department of Public Gardens and Plantations, (ii) the Agricultural Society, (iii) the Chemist's Department which is to be re-organised, and (iv) an Experiment and Teaching Station which is to be created. The Board of Agriculture is to consist of certain ex-officio members and of six other members to be appointed by the Governor. The present Department is to continue much on its present lines with changes in detail only; the Agricultural Society is to continue to utilise the help of the leading practical agriculturists of the Island; the Chemist's department is to be mainly agricultural, the laboratory being moved to the Experiment Station grounds, and is to be strengthened by the appointment of a competent assistant chemist in addition to the present assistant; the Experiment and Teaching Station is to be allied with University College on its teaching side, and to have an Agricultural Lecturer provided for by the funds of the Imperial Department.

With this brief sketch of the history and present position of the proposed Department of Agriculture I will proceed next to point out what agricultural teaching is at present being given by public bodies in Jamaica. It will be remembered that Mr. Fawcett last year read two papers concerning the work that had been done by his department in training the boys of an Industrial School placed on the land of the principal gardens at Hope, and in reaching the small settler with practical field instruction. There is no need to say more of these two lines of effort than he said in those papers. A few boys from the High School have also during part of the past year received practical agricultural teaching and training, giving eight hours a week to this side of their work. The Education Department and Board of Education have to deal only with the Elementary Schools, which the children leave at latest at the age of 14. They have to contend with insufficient financial help, and consequently insufficient numbers of school teachers and low pay for them. They have accordingly been unable to do more than encourage by small grants the few teachers who happen to be competent to give agricultural teaching and to procure the Tropical Readers mentioned here last year. The result has been teaching of some real value in a very few schools and in a somewhat larger number the kind of instruction which is of no great educational value. The further development of this teaching has for the last year been awaiting the decision to be arrived at as to the Department of Agriculture and the Experiment Station. I shall refer later to a series of Resolutions passed by the Board of Education in October in anticipation of the formation of the Department and Station.

I proceed next, before coming to the education proposed to be given in Jamaica, which is the subject of my paper, to deal

briefly with the different classes of agricultural education given in the United States and Canada. I shall mainly abstract from my own report to the Government of Jamaica made on January 6th 1897, adding information lately received as to extension work which is being done in the State of New York by Cornell University. The teaching institutions everywhere in the United States are in connection with experiment stations. It is felt that while the obligation to teach must use up a good deal of the experimenter's time, and there is some drawback to the value of a person as a teacher whose time and attention are mainly devoted to experiment, there are great compensating advantages in keeping the teacher in continual touch with actual investigation and in keeping the experimenter in touch with the difficulties felt by the "man in the street;" and that in any case conditions of expense make the union of the two classes of work necessary.

The teaching work in America is carried on (i) in Agricultural Departments of General Universities, (ii) in Agricultural Colleges and Schools, (iii) at Farmers' Institutes. I may mention of those I know, Minnesota and Cornell as good examples of the first class though smaller than Kansas or Michigan which I did not visit; Storrs in Connecticut, Amherst in Massachusetts, and Guelph in Ontario as examples of the second class, and the Farmers' Institutes in Wisconsin and Ontario of the third.

I pass by the four years' course which leads up to a degree, and is intended to produce a scientific agriculturist, able to direct or teach others, and which may be extended by post-graduate courses. Such a course is equally beyond our means and our needs.

As a specimen of the two years' course, for youths of the average age of 18 or 19, I give the outline of work at Guelph in some detail:

i. AGRICULTURE &c. Soils, reclamation of land, preparation of land for crops, succession of crops, cultivation of crops, improvement of soils and land, breeding, rearing and feeding of animals, poultry, bees, farm implements, general business of the farm, dairying.

ii. NATURAL SCIENCE—Chemical Physics, Inorganic Chemistry, Organic Chemistry, Agricultural Chemistry, Analytical Chemistry, Geology, Structural and Physiological Botany, Systematic and Economic Botany, Practical Botany, Zoology, Economic Entomology.

iii. HORTICULTURE including arboriculture, orchards, fruit plantations and gardening.

iv. VETERINARY SCIENCE.

v. ENGLISH AND POLITICAL ECONOMY.

vi. MATHEMATICS AND BOOK-KEEPING. -Arithmetic, Mensuration, Algebra, Physics, Book-keeping, Drawing

The Farmers' Institutes do something like the work amongst the small settlers described by Mr. Fawcett, with many differences arising from the very different characters of the persons to be dealt with, but still like it in the essential point

of bringing teaching, discussion and demonstration to the actual cultivator in his own district. In America as in Mr. Fawcett's system, the district must desire the central help and take steps to meet it before it is given.

The extension work that has been begun by Cornell University during the last three years is very interesting, and their experience should, I think, help us to the solution of some of the problems that face us. It was begun by a vote from the State of New York of $8,000 in 1894, which has since been increased to an annual vote of $16,000, and its operations are confined to North Eastern New York, about one third of the State I think. The object is by the law threefold, "conducting investigations and experiments," "disseminating horticultural knowledge by experiments or otherwise," and "preparing and printing" the results of the work; in other words research, teaching, publication. "Fortunately," says Professor Bailey, "we have been greatly aided by hard times and the multitudes of bugs and special difficulties," a form of aid that we have at present very abundantly in the West Indies. The Cornell Station has been experimenting on methods, and the history of their attempts is very interesting; but I have only space for the results up to date. They have come to the conclusion that setting people experimenting is the way to teach them, the value of experiments not lying in their results but in the teaching obtained in the performance of them. They further hold "schools" for the farmers and go to inspect and advise upon the actual difficulties of the individual farmer upon the spot: they recommend books to be read, working with the readers by means of correspondence teaching, and issue bulletins of the plainest and simplest kind. In the primary schools they have decided that you cannot teach agriculture in the proper sense of the word; but that the first thing is to teach the children to see and to reason from what they see, and to love the natural world. They have accordingly set to work to teach the teacher, and interest her in the work by means of itinerant teaching and bulletins. I give a list of the bulletins issued up to January 1899:—

1. How a squash plant gets out of the seed.
2. How a candle burns.
3. Four apple twigs.
4. A children's garden.
5. Some tent makers.
6. What is nature study?
7. Hints on making collections of insects.
8. The leaves and acorns of our common oaks.
9. The life history of the toad.
10. The birds and I.
11. Life in an aquarium.
12. Hints on rural school grounds.

They are trying to interest the children by getting up "Junior Naturalist Clubs" in the schools, and issue letters of instruction and still more elementary leaflets than those mentioned to the members of these Clubs with such titles as

The story an apple tree can tell

How to get the toad to tell his story.
The brothers and sisters who live in a tent.

This work is being energetically pushed and is warmly supported by the State Department of Agriculture, and by Dr. True and Professor Wiley at Washington. I have cited it as being on its own lines the most advanced work, pioneer work in fact, in the United States.

I now return from this digression to our proposed work in Jamaica. It should be remembered that it is at present a scheme on paper, and a scheme the successful working of which will depend upon the services of agents some of whom are at present unknown quantities: it is certain, therefore, that as we come to work it, it will be much modified; but it will equally certainly be tried on its main lines. The problem is to train (i) the labourer, (ii) the director of labour, and (iii) the small-settler class, a very large one in Jamaica, in which the two offices are united in the same person. The work in the elementary school will be aimed at preparing the members of this third class to be more efficient and useful cultivators of the ground. The Station cannot to any great extent go to the School; but it is proposed that it shall train the teachers.

The Board of Education has resolved that the teaching "should be mainly experimental, but that mere field labour forms no part of the programme of an ordinary primary school; that the teaching should be upon the lines of the French system, and the experiments such as those laid down therein, including *(a)* simple chemical and physical teaching by experiment on the gases etc. and *(b)* experiments in germination, plant-life, use of manures, cultivation etc; that this second class of experiments should be carried out with plants grown in pots and boxes, but preferably, where land can be obtained, in an experimental plot of ground; that the ground should be used as a place for illustrating experimentally the teaching given in the school room, and not as a place of labour beyond what is required for carrying out the experiments. The pupils should participate in the operations to an extent regulated by their age and manual capabilities as well as by their scientific knowledge. The work must be rational, requiring the exercise of the intellectual faculties as well as the labour of the hands."

The part it is proposed that the station should take in this work is educating the teachers to give the training spoken of. It is proposed to teach existing teachers by giving lectures in different parts of the Island but chiefly by bringing them in batches to the station, utilising the accomodation that the training Colleges can afford during their own vacations. The training required for future teachers is to be given by the Station to the students in the training Colleges. This work will, we hope, be the first undertaken by the Agricultural Lecturer who is to commence work this month. We are waiting for his assistance in finally settling the syllabus of the teaching to be given (1) in the schools and (2) to the teachers.

So far we know where we are, and what we can do, but when we come to the teaching to be given to the Proprietor class we are met by the difficulty referred to here last year,

viz, the absence of conviction on the part of members of that class that any technical education is needed by them, and the absence of a career for youths who may be trained, hoping to be employed on estates and pens. We have to create the demand and I take it that that can only be done by gradual demonstration, spreading over years, that the Experiment Station is doing valuable work on the practical side, and that its methods have money in them. This has been the course in the United States and Canada, and after thirty years it is by no means complete. I was told by a Canadian only a few days ago that the boys trained at Guelph always started out by failing, and after this they kicked over their training and succeeded. One may perhaps admit a grain of truth in this, and still believe that the ultimate success was the result of the training, tempered by experience, and not the result of kicking over the training. I feel sure that the demand for agricultural education in Jamaica will at first be very small, but will grow just in so far as our courses are practical and really useful and demonstrate that they are so. With regard to the want of a career, as agriculture becomes more scientific, the proprietors will find themselves forced to employ scientifically trained overseers etc, or to go to the wall.

The course at present intended to be given is that laid down by Messrs. Watts, Fawcett and myself in the report already referred to.

One idea is that pupils in our High Schools intended to become agriculturists should give about half of their school time during their last two years there to agricultural subjects, and that the Station should provide teaching for them, which would also be available to youths who have left school and to older persons who require a course in any particular subject.

We suggested as the course: —Agricultural Chemistry including theory of Agriculture. Two lectures a week each of one hour's duration.

(2) Practical Chemistry ; two lessons or demonstrations a week each of two hours' duration.

(3) Practical Instruction in Agricultural Methods and Practice ; (*a*) in the field : three lessons or demonstrations a week each of three hours' duration ; (*b*) in the laboratory or class room in extension of the field or lecture work. One lesson a week of one and a half to two hours' duration.

(4) Plant Physiology and Botany as applied to agriculture. One lesson a week of one hour's duration.

(5) Veterinary Instruction. One lecture a week of one hour's duration, during two terms of the year.

(6) Agricultural Entomology, insect life, injurious and beneficial insects. One lecture a week of one hour's duration for one term in the year.

(7) Book-keeping should be taught in the schools, instruction being given in the methods suitable for use on plantations.

(8) Mensuration, Landmeasuring, etc. should be taught partly in the schools and partly by practice at the station.

The staff of station officers to give this teaching are the Agricultural Lecturer, the Agricultural Chemist, Mr. Fawcett and the officer of his department actually in charge of the cultivation at the station. It is hoped that the Entomological teaching will be given by the Curator of the Museum of the Jamaica Institute: but the Veterinary and Land Surveying teaching will have to be given by persons specially engaged.

The lecture room will be at University College, which adjoins the site of the station, and the laboratory work at a laboratory adjoining the Government laboratory on the station ground.

The Science teaching in the lower classes of the High School and probably of other secondary schools will be so arranged as to be preparatory to this course.

It will be observed that the scheme is in many points like that laid down by Professor d'Albuquerque in his paper on the subject last year as it is also much like that laid down by myself in my Report in 1897. We are looking to the Imperial Department for the compilation of text books. As a preliminary step a bulletin giving a list of the most useful existing text books would be a help to us. I doubt not that five years hence we shall find that many points have been modified, as much is still inchoate; but I also hope that we shall find that we have begun to demonstrate in letters easy to be read by all men that in these days of progress and competition a modicum of scientific instruction is as necessary to success in agriculture as it is in any other calling,

AGRICULTURAL EXPERIMENT WORK AT TRINIDAD.

BY J. H. HART, F.L.S.

Superintendent of the Royal Botanic Gardens, Trinidad.

For many years it had been recognised that the establishment so long known as the Royal Botanic Gardens of Trinidad, had not sufficient accommodation to enable it to take its due share in the teaching and practice of agricultural methods, or to carry out desirable experiments in the interests of the agricultural community.

Certain experiments were carried out as far as the limited space at disposal allowed, and considerable success was attained. This success was used as an argument with the Government with the view of providing larger and better accommodation, and to this the sanction of the Secretary of State was obtained through the efforts of Sir H. E. H. Jerningham, K.C.M.G., who warmly supported the suggestion. The Botanical Department was on the 1st January 1898, put into possession of a suitable

area of land, a portion of the St. Clair Estate, situate about three quarters of a mile distant from the centre of the older establishment.

The area of the plot is over 33 acres, subdivided into three sections of three, fourteen and sixteen acres each. The first portion has been planted entirely with the best selection of fruit trees obtainable. Some grafted oranges and mangoes are already well established. The second section is intended for scientific and botanical work, and is gradually being brought into use as a Botanical centre. In this section it is intended to place the offices and residence for the Curator. The old establishment will furnish gradually much material, but considerable time must elapse before any rapid progress can be made unless a construction vote be provided. Otherwise, the work must be done as opportunity offers with the regular staff. Numerous trees of permanent value have already been planted and during the coming year it is hoped to have the ground-plan well advanced. The third section is entirely devoted to economics and is already laid out into sections containing rubber, coffee, cacao, vanilla, pepper, fibres, dye-stuffs, tannias, food-products and vegetables, grasses, oranges, lemons, Bergamot oranges, pimento, etc., etc. The sections are accurately measured into equal parts of an acre, so that the value of the produce can easily be calculated.

Among the objects provided for is the growth of material on which demonstrations can be given, on cultivation, pruning, training, manuring, etc., etc. Special varieties of plants are also grown which are to be propagated by grafting so as to be able to distribute known and serviceable kinds to planters, instead of having as heretofore to rely upon seedling produce. The improvement of plants by seminal selection is to form one of the primary duties of the station; and this is to be secured by the best known methods, as was indicated in my paper on the subject read at the last Conference.

Selections are made of the best fruits obtainable in the West Indian markets, and the seeds of these are sown, and a choice made of the best produce for the purpose of distribution. In this way the amount of variation from seed of the various fruits can be noted and recorded. A set of seedlings raised from seeds of our best named mangoes is already planted out. I show here to-day two oranges produced by trees raised from the same fruit which illustrate the very considerable amount of variation possible in one generation when grown from seed only.

Trials are being made of new plants sent from various parts of the world. Conspicuous among these are *Coffea stenophylla*, a new coffee from Africa and the new African Rubber *Kickxia sp.* Abbeokuta coffee has proved to be a variety of Liberian with a somewhat smaller berry. So far however, it is shown to be especially hardy, and flourishes with a less amount of shade than other kinds. We have trees of *Kickxia* over six feet in height, and these are now flowering and seeding for the first time. Juice has been extracted from the stems of some of the largest of these, and good rubber has been made

The nurseries are in the third section, and contain some 200,000 plants of various kinds for sale and distribution. The receipts for the past year have reached over £400 and there promises to be an increasing demand.

Intelligent boys from the labouring classes are taken on in the nurseries as apprentices and trained in the various methods of raising and cultivating plants. These readily obtain good wages when they leave us.

A system of cadetships has recently been instituted for young men of a better class, and these are in receipt of regular, and also special instruction, at certain periods.

Classes of schoolmasters are proposed to be taken in January and August of each year In August 1898, 20 men attended a three-weeks' course, and I am pleased to say gave earnest attention to the instruction afforded, and the majority passed an excellent examination The course consisted of lectures and demonstrations on the theory and practice of tropical agriculture. The second course commenced on January 2nd. The following is a syllabus of the course at the Experiment Station .

(a) —THEORETICAL

Culture of the soil.
Plant forms.
Flowers and reproduction.
Seeds and germination.
Roots their forms and functions.
Physiology of plants.
Botanical classification and nomenclature.
Insect life.
Diseases of plants
Culture of sugar cane.
Improvement of plants by selection.
Fibres and fibrous plants.
General economic Botany.

(b)—PRACTICAL

Digging, forking, &c.
Fertilization and hybridisation.
Propagation of plants.
Seed-sowing and seed-treatment.
Potting and planting.
Watering and syringing.
Grafting and budding.
Pruning and training plants.
Manuring and mulching.
Draining, levelling, grading &c.
General cultivation, weeding, hoeing &c.
Preparation and use of insecticides &c.
Composition of soils for nursery uses.
General practice.

In addition to the botanical course a further course in

chemistry is given to schoolmasters by the Professor of Chemistry at the Government Laboratory.

The method of teaching agriculture which has been followed in Trinidad, is the only one possible, without addition to the present staff of officers. This staff is already so fully employed that it would be impossible to undertake itinerant teaching. I am, however, of opinion that the present plan is a valuable means of disseminating information to the rural population on matters of agricultural interest, and especially as a help to the training of children in agricultural theory and practice.

The whole of the work on the experiment station has up to the present been carried on by the aid of a small addition to the original vote for the Botanical Department, but without an increase in the staff.

The Tobago Botanic Station which has been recently established, is supported from Imperial funds. It is supervised by the Trinidad Department. It was only started during the past year, but is making rapid progress under Mr. Millen. Visits of inspection are paid by the Superintendent of the Trinidad Gardens at intervals of about three months each and reports are furnished for the information of the Department of Agriculture. Considerable interest has been created in the island in agricultural progress and it is hoped that eventually much good will result from the operations of this Station.

DISCUSSION.

The PRESIDENT: Mr. Hart's paper deals with numerous points. It is evident that the Colony of Trinidad will derive considerable advantage from the Experiment Garden established through the efforts of the present Governor at St. Clair. Not the least interesting of the several agencies now in active operation is the educational work described by Mr. Hart. As a teaching centre in the details of agricultural and horticultural methods St. Clair should carry out a good deal of the work proposed to be undertaken also at Jamaica and so well described in the interesting paper just read by the Rev. Canon Simms.

The Conference then adjourned (at 1 o'clock) for luncheon. After luncheon the Conference resumed at 2 o'clock.

GENERAL.

OBSERVATIONS ON THE FOOD SUPPLIES OF SOME WEST INDIAN ISLANDS.

BY THE HON'BLE FRANCIS WATTS, F.I.C., F.C.S.

Government Analytical and Agricultural Chemist to the Leeward Islands.

There are many points connected with the food supplies of the West Indies which will prove of interest to those engaged in the work of the Department of Agriculture, and it is reasonable to hope that the work of the Department will, in turn, exercise an important influence on the character and quantity of food available. Hard pressed as these islands are some relief may perhaps result from improvements in the supplies of food wherefrom may arise greater efficiency in the production of the staple crops for export, and greater ability to withstand the competition of other countries, a competition which grows keener day by day.

These food supplies fall into two great divisions, those which are imported, and those which are grown locally. For purely agricultural countries the quantities of imported food consumed in the West Indies appear very large; taking the case of the Leeward Islands, (in which for the present I am more particularly interested,) we find that the value of foods imported (exclusive of articles of drink) was £132,315 in 1897 and £132,728 in 1898: the chief items were in 1898:—

Wheat Flour	£42,997	
Corn Meal	13,743	
Breadstuffs	8,016	
Rice	7,129	
Peas and Beans	920	72,805
Dried or Salted Fish	£17,633	
Salt Pork	10,835	
Salt Beef	1,056	
Pickled Herrings	3,589	
Butter	3,879	
Margarine	2,737	39,729
		112,534
Other articles...	£20,194	20,194
Total		£132,728

The population of these islands is 147,723.
Total imports in 1897 £312,557. In 1898 £295,381.
Total exports „ £315,136. „ £273,280.

In looking over such a list the thought naturally arises that these agricultural colonies should be able to produce for themselves much which they now import, and that such a course should lead to increased prosperity. It is sometimes suggested that it is economically sound for colonies such as

these, having a staple like sugar or cacao to export, to import large proportions of their food supplies. Such an argument, I think, implies that the energies of the people and the resources of the land are profitably engaged in the staple industry. This, however, is not the case, for in most of the West Indian islands we have a number of people either unemployed, or partially employed, while in nearly every colony there are considerable tracts of uncultivated land. Under these circumstances it must be economically beneficial to turn some of this unemployed energy and land to account by producing food; the staple crops should provide sufficient material for export and the means of wage-earning necessary for the maintenance of healthy economic conditions.

In the case under consideration wheat flour and salt fish form the chief items of food imported: these possess advantages peculiar to themselves and could hardly be displaced, yet the free production of home-grown foods might lead to considerable substitution of other foods for these. Corn meal is the next article in importance: though it would be difficult or impossible to do without imported meal entirely, yet it would be of great advantage were corn meal of home production largely substituted for imported meal. Salt pork, which occupies a prominent place on the list, is chiefly employed as a convenient source of oil or fat and not as a nitrogenous food. The creation of a local oil industry would lead to the employment of oil for many of the purposes for which salt pork now does duty. The increased production of home-grown foods would render it possible to raise pigs in a systematic manner, with a consequent further reduction in the quantity of pork, salt meat and fish imported. For much of the rice, local meals or grains might be substituted.

It requires little effort of imagination to see the possibility of substituting, in the Leeward Islands, some £30,000 or £40,000 worth of home-grown for imported food, and this also applies to other West Indian colonies.

In this connection it is worth bearing in mind that when a home-grown article costs the consumer the same amount as a similar article imported, it is not a matter of indifference to the community which article shall be used; if the imported article is used, the value of it is exported and is used in a distant country, whereas if the home-grown article is consumed the whole value remains in the country, to be again usefully employed in raising similar useful articles. It might be a matter of indifference were everyone beneficially employed and were all the land profitably engaged in raising crops, but when the case is applied to our conditions, and we see people partially employed and much land uncultivated, it would appear by no means a matter of indifference what course is followed.

It is impossible to obtain a statistical return of the quantities of home-grown food of various kinds raised in the Leeward Islands, but the amount is not inconsiderable. It may be of interest however to enumerate some of the most important.

It is admitted, that so far as the sugar producing islands are concerned, the sweet potato occupies the foremost place in

the list of home-grown foods and is, probably, next to the sugar cane, the most important crop grown. During the period from about December to March, this food is most abundant, and the price being very low, it constitutes a large part of the diet of the labouring class. In composition the sweet potato agrees closely with the "Irish" potato and, like that, contains a smaller proportion of protein in relation to the carbohydrates than a well balanced diet demands. There are many varieties; many of these have been studied at the Experiment Stations in the United States, but it is very desirable that we in these islands should possess a more accurate knowledge than we now have, of the peculiarities of the various kinds: much might perhaps be done by the introduction of varieties bearing heavier crops, or more suitable for particular situations, or ripening at different times from those commonly grown, or, most important if attainable, richer in protein. The importance of the crop warrants careful study and in this direction the Imperial Department of Agriculture may do good work. At present the crop is grown upon the sugar estates as a snatch crop, and fulfils a useful purpose; owing to the short time it requires to come to maturity it can be planted after the (ratoon) canes have been cut when the potato crop will be ready for reaping from about December to February: after the crop has been reaped the land may be quickly prepared for a crop of sugar cane. As the potatoes usually meet with a ready sale the crop is one of value to the sugar planter, and acceptable to the labourer. Sweet potatoes are largely grown by the peasantry themselves, the ease with which they are propagated, the poor soil in which they will thrive, the small amount of attention which they require during their growth and the short time in which they come to maturity, all commend them to the peasant.

Yams rank next to potatoes in importance in the sugar growing islands; they require richer soil and take longer to come to maturity than potatoes, they keep better than potatoes and for this reason they are seldom sold at the very low prices which potatoes bring, for they may be stored, should there happen to be a glut in the market and prices rule low. In connection with yams there is much "Station work" of interest to be done.

Cassava is widely cultivated as a food crop: perhaps it is cultivated to a smaller extent in Antigua than in the other islands; for its full development it requires friable, well-drained and fertile soil, whilst in most parts of Antigua the soil is heavy. This crop thrives well in St. Kitts and Dominica. The well-known cassava bread is prepared in all the places where the crop is grown, but the preparation of the meal, known as farine appears to be more commonly practised in Dominica and the Windward Islands than in the Leeward Islands. Cassava takes about a year to come to maturity a fact which places it at a disadvantage when compared with sweet potato; it has also the disadvantage that its poisonous character precludes its being eaten without special care in its preparation.

Eddoes and tannias are the remaining root-crops of interest; they are often grown as field crops on sugar estates,

but more frequently by the peasantry themselves in their provision grounds.

Bananas do not occupy the important position in the category of food crops in the Leeward Islands that they do in some of the other islands. In making this statement Dominica must be excepted, for in that island bananas occupy an important place. The peasant it is who chiefly grows bananas in their various forms; they are but sparingly grown by the larger planters.

Corn is not extensively grown as human food in the Leeward Islands although corn meal forms such an item in the list of imports. Such corn as is used is usually roasted in the cob and eaten in that condition, very little is done in the preparation of meal. This useful article of food suffers under several disadvantages: the growing cobs are liable to be stolen, when gathered the grain is liable to damage from insect attack, while the preparation of meal is a somewhat tedious operation. For these and similar reasons home-grown corn is not such a prominent article of diet as one might expect. At this time I do not wish to make more than a passing allusion to the question of thefts of growing crops; this is an evil of the most wide-spread character working infinite mischief in all directions, and one for which some remedy must be found if there is to be material progress in the West Indies.

Peas and beans occupy a small but not negligeable place in the food supply of these islands. They are rarely seenas extensive field crops except where a leguminous crop is being grown as a green dressing. This appears to be a weak spot in our Agricultural system, and it is desirable that leguminous crops should be found which will admit of profitable cultivation on a large scale.

Sugar in various forms, as sugar cane, syrup, muscovado sugar or molasses, is a very prominent article in the diet of the labouring population. Doubtless it is an excellent food, but owing to the absence of protein it aggravates the defect of the usual diet, the deficiency of nitrogen.

Various green vegetables are extensively used, as squashes, pumpkins, ochros, eddoe tops, and a species of amaranthus, common as a weed. Here again there is a wide field for "Station work" for many hitherto unused or little used plants may be found to be useful as articles of food.

Of animal foods pork is the one by far the most commonly employed, and no doubt much larger quantities would be used if it could be procured at cheaper rates, a point which might be arrived at if more home-grown food were used, so that waste, offal and damaged supplies could be utilised for pig-feeding on a large scale.

Beef, mutton and poultry enter but sparingly into the diet of the peasantry, being for the most part too dear.

Fish is in somewhat irregular supply, sometimes it is abundant and cheap and is taken full advantage of by those to whom it is accessible.

If we examine the list of crops grown locally for food we observe that most of the products are such as will not keep

for any considerable length of time. Sweet potatoes, cassava and eddoes will not keep long after being dug, nor bananas after being gathered. Yams will keep for a longer time. The grains, corn and Guinea corn, will keep for a considerable length of time under proper conditions; they are, however, very liable to the attack of weevils and other insects and no systematic attempts are made to preserve them from these attacks. On the whole then it may be said that the home-grown foods are of a perishable nature, so that they must be consumed within a short time of their coming to maturity; they cannot be readily stored.

Again it is to be noted that there is not a regular and uniform supply of home-grown foods. At times they are in excessive supply, at others there is scarcity; it also happens for the most part that these foods are most abundant at a time when work is plentiful and the labourer is earning good wages, while, unfortunately the scarcity arrives when small wages are being earned and the purchasing power of the labourer is at its lowest. This has a disturbing effect upon the labour supply. When there is much work to be done there is abundant and cheap food with consequently little inducement to work, while, when food is dear and labourers are desirous of finding employment there is little work to be done. It is probable that circumstances such as these have a wider effect than is generally recognised in moulding the habits and thoughts of several classes of the community.

Another point deserves notice. Owing to the uncertainty of the supply, the means of distributing home-grown foods are often very defective; even in the smaller islands there may exist an excessive supply of some article of food in one district, while there may be scarcity in another. Locally grown crops are largely consumed in the districts in which they are raised.

The uncertainties thus introduced, owing to defective keeping properties, irregularity and uncertainty of supply, absence of adequate facilities for distribution, lead to greater reliance being placed on imported foods which are always obtainable at almost uniform rates, which will keep almost indefinitely and for the distribution of which tolerably good facilities exist. One of the most striking instances of the operation of these causes is to be seen in the very large consumption of condensed milk in Jamaica, a country largely dependent upon cattle-raising as an industry.

These home-grown supplies are, as a rule, employed directly as foods, little attempt is made to convert them into forms which will keep and thus equalise the supplies which are otherwise irregular: it seems probable that something will have to be done in this direction before much progress will be made in the substitution of locally grown for imported foods.

There are various ways in which some, at least, of these foods may be manipulated in order to prolong the time over which they may be kept. From many of the roots and tubers starch may be produced, which will keep indefinitely. This has advantages, though it must be remembered that the preparation of starch involves the loss of all the protein and mineral constituents of the food. In some of the islands the manufacture

of starch is carried on on a large scale, notably in the instances of the manufacture of arrowroot in St. Vincent and to a smaller extent in Montserrat. From both of these islands arrowroot forms an article of export. There is perhaps room for small extension of the preparation of starches in the islands possessing a good water supply. Dominica and St. Kitts, for instance, should produce all required for their own consumption.

The preparation of meals from starchy roots and tubers has the advantage over the preparation of starches in that all the constituents, except water, are preserved and there is no loss of protein and mineral matters; meals thus constitute better foods than the starch produced from the same plant. From one crop, cassava, meal is produced extensively in some of the islands under the name of "Farine": very little of this is prepared in either Antigua or St. Kitts: the art is much more commonly practised in the Windward islands and generally in those places where French influences have been strongly felt. The preparation of cassava bread is closely allied to the preparation of farine. It is to be wished that this art of preparing farine could be introduced more extensively into those islands where at present it is but little practised. Vigorous efforts have been made to this end by the Agricultural Society of Jamaica and it is believed that these efforts have been successful, in some districts, in leading the peasantry to understand and appreciate the uses of this source of food. This example commends itself for imitation in some of the other islands.

It is curious that few attempts are made to prepare other root meals than farine. Sweet potatoes and yams may readily be converted into meal, in which condition they would keep indefinitely and form a useful means of equalising the supply of food and tending to keep prices at a more uniform level. Though these two may not be quite so easy to manipulate as cassava, yet I believe no great difficulty would be experienced in slicing the tubers in a machine of the nature of a mangel or swede pulper and drying the slices in an appliance constructed on the lines of a fruit drier: to be efficient it is important that there should be a rapid current of air passing through these driers, a point in which they are sometimes defective. After the slices are dried they would be readily reduced to meal. The following analysis of sweet potato meal prepared in Antigua, was made by Voelcker. For comparison I have calculated the percentage composition of meal from the average of 88 samples of fresh potatoes as recorded by Atwater and Woods:—

	Voelcker.	Calculated.
Water	11·99	12·00
Protein	5·12	5·16
Fat	1·19	2·00
Sugar	9·90	
Soluble Carbohydrates ...	67·01	77·68
Fibre	1·89	
Ash	2·90	3·15
	100·00	99·99

In Jamaica attempts have been made for years to create a market for banana meal, hitherto without much success, largely, I imagine, from the fact that the desire has been to export the meal rather than encourage the local consumption.

All these meals, whether sold locally or exported, come into competition with commodities of similar character already on the market: these new meals, for the most part, possess no striking feature to recommend them in preference to other, established, meals; it is obvious therefore that their price must be determined by the price of these established articles. As foods they will be regulated in price by the value of such commodities as wheat and corn meals and will be sold at lower prices than either; exceptional prices may in some cases be obtained by special preparation and advertising in order to create special markets, but this is beyond the scope of the present enquiry. As substances to be employed in manufacturing industries, as for example the manufacture of glucose or in brewing, they must compete with such articles as sago meal and corn. The value of maize in New York in 1897 ranged from 31 to 37½ cents per bushel; while in Kansas City in the same year prices ranged from 22 to 26 cents. It is interesting to note here that some 10,000,000 bushels of maize are annually consumed in the production of glucose in the United States, and probably more than that quantity in the brewing and distilling industries.

In most of the previous discussions which I have heard respecting the desirability of preparing meals, stress has been laid on the export trade and the finding of markets in other countries; if this is the end in view it is very clear that prices will have to be very low and that the preparations of these meals must be carried on on an enormous scale in order to prove remunerative.

If on the other hand these meals are regarded as the means of supplying local demands, of utilising local food supplies when they are at their cheapest and conserving them for use at times when other supplies are scarce, then it will be possible to obtain better prices. The industries can be carried on on a smaller scale much more within the capacity of the small colonies, at any rate during the early stages of development, than would be demanded by any effort to secure an export trade. Every local Agricultural Show or Exhibition brings to our notice the efforts which are being made to prepare meals of the kind under discussion; it seems very desirable that these efforts should be directed in the right channels.

Although a large amount of corn meal is consumed in the islands little or none is of local production. This is perhaps partly due to the fact that home made meal will not keep well; the corn meal imported is not simply the crushed grain, the milling process is a complicated one during which certain portions of the grain, the germ and the husk, are removed: the germ contains a considerable quantity of oil and at the same time it is hygroscopic. These features are inimical to long keeping and meal containing the germ has a tendency to become mouldy and rancid, while meal without the germ keeps well.

The machinery for milling corn and removing the germ during the process would prove far too costly to be introduced into these islands, any meal which may be made locally will therefore consist merely of the crushed grain, though perhaps a simple form of bolting or sifting may be introduced. Such meal is deficient in keeping qualities but it is of superior flavour and of higher nutritive value; meal of this kind is usually preferred by those who can obtain it, and should facilities be found for the local production of this meal doubtless its use would be very general.

The various forms of Guinea corn are but little used as food in the Leeward Islands: considering the ease with which this crop is grown and the considerable yield of grain obtainable from some of the varieties this is to be regretted. This neglect arises, I think, from several causes; some little trouble is necessary to separate the grain, the grain is very subject to insect attacks, there are no mills for preparing the meal and the grain is regarded as a coarse food suited for horses and mules. The composition of Guinea corn meal is similar to that of maize meal, for which it might be largely substituted. There is a large field for study in the various kinds of Guinea corn and there is reason to believe that careful investigations may lead to the extensive use of this grain as human food in the West Indies. The subject is one which commends itself to the attention of the Department of Agriculture. An early effort should be made to find a suitable threshing and winnowing machine and suitable small mills; at the same time a careful and systematic study of all the available varieties should be made on the demonstration plots of the stations.

In some of the islands it might be to advantage if small mills were introduced for the preparation of these meals; in this work the Department might assist, either by the introduction of a pioneer mill, or by assisting some enterprising individual to establish one. Mills for this purpose need not to be costly affairs and the cost of working should be small; wind power would be very suitable for these mills were they largely introduced, for the grain to be ground is not a perishable commodity, so that occasional delays are of little moment, nor will occasional delays be of much importance in the matter of labour for the mills may be largely self-feeding. The introduction of these mills might ultimately have a pronounced influence on the commerce and agriculture of the islands. They would stimulate industry, they would lead to the utilisation of crops now neglected, thus opening new fields to the agriculturists; the food supplies of the people would be increased, and the introduction of new industries could not fail to exercise a stimulating influence on general agriculture. It is very desirable that a greater diversity of crops should be grown than is now the case, and the suggestions which I now make tend, in some measure, to secure this. The efforts of the peasant in the cultivation of his own provision grounds are of much importance; by intelligent direction, they may be much extended and improved. This may be most surely arrived at by making the stations of the Department of Agriculture, demonstration stations, where the lessons which it is desired to inculcate may be constantly seen and

slowly assimilated. Every Station should have plots whereon demonstrations should be constantly in progress showing the best kinds of each particular food plant and the best methods of cultivation. At the same time the work of the large estates is equally of importance in this connection. The growing and preparing of food crops may become a prominent feature in the management of a sugar estate, giving more regular employment to the hands engaged and greater variety to the crops grown and sold, all highly desirable from an economic point of view.

Investigations into the character of the food consumed by the negro population of the Southern States have led to the recognition of the fact that the diet of the people of those regions is deficient in protein even where the food is fairly abundant in quantity ; the tendency is to consume food rich in carbohydrates and fat, but poor in protein, because food of this character is most easily obtainable. The dietary conditions of our labouring classes appear to be very similar to those of the Southern States and the same deficiency in protein is to be noticed. With the exception of the dietary scales of the prisons and similar institutions there exist no accurate data bearing upon the food consumed in these islands, but a review of the food supplies available indicates broadly that this is the fact. The imported food contains only one item of importance which is very rich in protein, namely salt fish, which is imported in quantity equal to 15 lbs. per annum per head of population. Salt pork, the animal food next in importance, cannot be regarded as supplying any considerable amount of protein, for the importations consist almost entire y of fat pork, which according to the American analyses, shows only about 7 or 8 per cent of protein, or about the same proportion as corn meal. The locally grown food inclines decidedly towards excess of carbohydrates in comparison with the proportion of protein, and as this condition is ameliorated to any considerable extent only by the importation of salt fish it follows that the combined food supply, native and imported, is deficient in protein.

Referring to the dietary scale of the Leeward Islands' Prisons, I find that "full diet", supplied to male prisoners at "hard labour", supplies about ·11 pounds (or 51 grams) of protein and 2,530 calories of energy. Male prisoners not at "hard labour", or under 16 years of age and all female prisoners receive practically three-fourths of these amounts. Under these circumstances during a period of six months the result on the weight of the prisoners received and discharged was as follows :

	Lost Weight.	Gained Weight.	Weight unchanged.
Males, all classes (per 100)	60	22	18
Females „ „	23·2	32·1	44·7

A prison dietary, of necessity, is of a scanty nature, but it may be expected to approximate somewhat to the diet of the poorer classes. Judged by the ordinary standards this diet under consideration supplies about one-half the protein and eight-tenths of the energy of an ordinary diet. The male prisoners as a rule lost weight, so we may assume that they

were accustomed to receive more food prior to their imprisonment. The female prisoners, on the other hand, were inclined rather to gain in weight, a large proportion neither gaining nor losing, we may therefore conclude that this diet was at least equal to what they were receiving before incarceration. Taking these figures broadly then we may regard them as supporting the statement already made that the labouring classes subsist on a diet very poor in protein.

Mr. Cowley has been good enough to collect for me some data relating to the food consumed by the following:—

(1) A family consisting of a man, a woman, a youth of 17 years, and three girls aged 14, 6, and 3 years (equal to 4 men.)

(2) A man and one child of 6 years (equal to 1½ men.)

(3) One man.

(4) A family of 3 women, a youth of 18, another of 15, and two girls aged 17 and 4 years (equal to 5·3 men.)

The information thus obtained is doubtless only approximate, but in the absence of anything more accurate it may prove of interest. The average daily supply of protein and of energy per man in the several groups I estimate to be

Group.	Protein, lbs.	Energy, calories.
(1)	·13	1622
(2)	·18	2323
(3)	·27	5395
(4)	·14	3003

These figures present some similarity to those found by Atwater and Woods in their studies with reference to the food of the negro in Alabama in 1895 and 1896. They are too imperfect to admit of being applied very closely but they support the view that the diet is characterised by deficiency of protein; in the main the diet is also deficient in energy.

When these defects of the dietary are known it does not seem to me too much to hope that they may be remedied by degrees; much can be done by bringing new plants to the notice of all cultivators, large and small, by means of the Demonstration stations. Something too may be done in the schools and much by the Agricultural Societies.

The deficiency of protein may be met by more frequent use of various forms of beans and peas; these may be grown throughout the islands with ease; the addition of a few ounces of some form of pulse to the defective dietaries here mentioned would effect a vast improvement, an improvement which would be speedily seen in the increased health and vigour of the people. This opens up a wide field of work for various officers of the Department of Agriculture who may be charged with such duties as drawing attention to crops calculated to improve the dietaries, the inculcation of sound ideas in conjunction with the food consumed, and of watching generally the economic bearings of the habits of the community in relation to the food supply. These questions are of great importance, for, on a proper solution of them the prosperity of many of the islands may depend, particularly those where the struggle for existence is now very keenly felt. A proper use of

the food supplies available must constitute an important factor in the cost of production of the staple commodities and determine the ultimate success or failure of a country. I therefore venture to urge the consideration of the questions here briefly outlined upon the attention of the workers connected with the Imperial Department of Agriculture for the West Indies.

DISCUSSION.

THE PRESIDENT: Mr. Watts has opened up a most interesting and important field of action to all who are concerned in the welfare of the West Indies. The successful selection and cultivation of food plants is a matter intimately connected with the health and welfare of the labouring classes, and hence with their power to contribute to the general prosperity of these Colonies.

I hope to return to this subject at the next Conference. In the meantime it would be useful if a careful enquiry be made in each Colony of the extent and character of the food stuffs now produced and the steps necessary to be taken to improve the cultivation of old or the introduction of new food stuffs. It would be of value also to start experiments to test the productiveness of various varieties of sweet potatoes, cassava, eddoes, yams, rice, maize, guinea corn, sorghum, and their adaptability to local conditions. I am fully in accord with Mr. Watts in thinking that small mills and machinery for preparing and curing produce should be introduced and brought within reach of the peasantry. The Department of Agriculture would willingly help in this direction.

Rev. Dr. MORTON (Agricultural Society, Trinidad): I had the pleasure some years ago of introducing rice cultivation into St. Lucia. It would be interesting to know what progress, if any, has been made in that direction. It might be interesting also, to know whether rice cultivation could not be introduced into some other parts of the West Indies.

Two principal kinds of rice are cultivated in Trinidad a rice which ripens in ten weeks, and another which takes five months. We have a small mill for husking, but some of the people husk their rice in a mortar according as they want it. I may mention that in some parts of Trinidad there were areas of swampy land which none would buy unless they were obliged to take them in their lot. Later on, however, East Indian coolies bought them, and some of these lands are now our most successful rice fields. At present large stretches of land eastward of Port-of-Spain are being established with rice cultivation.

Mr. G. S. HUDSON (St. Lucia): in reply to the Rev. Dr. MORTON, I can say that the rice cultivation has been continued in St. Lucia, but it is still confined to the East Indian coolies.

As far as I can gather there is no inclination on the part of the people of St. Lucia to take it up. There are about fifty acres under cultivation. The paddy is husked in mortars.

MR. W. FAWCETT: In Jamaica several attempts have been made to extend the cultivation of rice in that island. Ten or eleven years ago a medical man in a western parish took great interest in it and erected a husking mill on his estate. Later, another planter in the same district took it up very energetically. We import seed rice of the best varieties for him from Calcutta. Another planter on the other side of the island, where there are extensive swamps, is doing the same thing. At present the industry is in an experimental stage. I believe that very soon a large amount of swampy land in Jamaica will be devoted to rice cultivation.

MR. J. J. QUELCH (British Guiana): The experience, so far in rice production in British Guiana has been an unfortunate one.* Rice has, and is being largely grown in the Colony but a factory erected for husking and cleaning rice in Georgetown has failed, probably, through mismanagement and the fact that the mill was not placed in a convenient and suitable position. Thousands of acres of land have been placed under rice cultivation and many East Indians, who have land of their own, practically support themselves by the rice they grow. There are extensive tracts all over the Colony which could be devoted to rice cultivation.

Besides rice there are numerous other foodstuffs that could be introduced, notably cassava, which forms the staff of life of the Caribs and other tribes on the Brazilian frontier. Indian corn or maize is also extensively grown. I have seen large villages where every house is filled with corn stored away for use during the dry season.

PROFESSOR HARRISON (British Guiana): I believe there are about 40,000 acres devoted to the growth of various food crops in the Colony.

DISTRIBUTION OF ECONOMIC PLANTS IN RELATION TO AGRICULTURAL DEVELOPMENT.

BY THE HON'BLE WILLIAM FAWCETT, B.SC., F.L.S.

Director of Public Gardens and Plantations, Jamaica.

One of the most important functions of a Botanic Garden in the tropics is to introduce economic plants from other parts

* In British Guiana, the Coolie population, in 1891, was 105,463. The value of rice imported into the Colony in 1895-1896 was £183,394. The conditions for growing rice, locally, are described as most favourable, [Ed. W.I.B.]

of the world, grow them, and if found suitable, distribute them throughout the district served by the Garden.

To the fulfilment of this duty, for more than 120 years by various botanic gardens in the island itself, Jamaica owes her practical independence at the present time, of depression occurring in any one particular industry.

During the last 20 years from the time that the Gardens in Jamaica were constituted a Department of Government under Dr. Morris as its first Director, special attention has been paid to this subject of distribution to all planters alike, rich and poor, on the very lowest terms.

Putting on one side altogether the distribution of plants of cinchona during the year 1875—1885, the number of economic plants distributed for 20 years amounts to at least 800,000. Supposing we estimate the value of these plants all round at only 3d. each, the money value would be £10,000.

But the mere money value is not the only thing to be thought of. We should consider the advantage to the island of having plants ready at a short notice when otherwise they could not have been supplied at all: also the number of years the colony is to the front in the struggle for existence when planters, great and small, can obtain what they want at once and of the best quality, backed up by the experience at their service, and the information collected from all parts of the world.

It would be exceedingly difficult to estimate what the increased value of the exports in any year would be, due to the action of the Botanic Gardens, but I believe that anyone who attempted the estimate for himself would be surprised at the total.

The general value of the distribution of economic plants to the island community is recognised, but the question is whether it is useful or necessary to work on the very large scale that is now adopted in Jamaica. Why should not planters be left to sow their own seeds and form their own nurseries? Sometimes planters do form their own nurseries, but frequently circumstances occur which interfere with success, and instead of waiting for another year or two, it is a great saving of time to be able to obtain established plants from the Botanic Gardens.

But there are other considerations. The division of efforts that exists in Europe and America in keeping nurseries quite distinct from the ordinary work of the farmer or planter is not the rule in the West Indies. Nursery work has been despised, or rather its importance in the tropics has not yet been fully recognised. Any kind of seed and any sort of treatment of the seedlings, has been considered good enough.

The Department of Public Gardens in Jamaica has taken the view on botanical grounds that seed and nurseries deserve very close attention and the application of scientific methods, and that the more complete the division of labour, the better will be the general results. In the absence therefore of nurseries carried on as a regular business and in a commercial way, the Department has taken up and systematically developed the

work. It recognises the importance of seed selection, the consideration of the maturity of the mother-plant, its vigour, the soil and climate where it is growing, and also the necessity for growing the seedlings under the best conditions so as to produce vigorous plants.

Great pains also are being taken in the distribution of the plants.

The mode of packing varies with the character of the plants. Some, like nutmeg and cacao, require to be sent in pots, as injury to the tap roots is fatal. The pots are made of bamboo joints in which the seeds are either sown or the seedlings transplanted. The pots are light and not easily broken in carriage ; they can be either planted at once or kept under shade and watered by the planter until favourable opportunities occur for taking them out into the fields and planting them in permanent positions without disturbing the soil and roots. Very much depends for success on the weather when planting of cacao takes place, the percentage of losses being less than 1 per cent. in favourable, showery weather, and perhaps as much as 50 per cent. when the weather is dry.

Other plants like coffee and orange, can be dealt with much more easily. They are simply tied up in small bundles with the roots well wrapped in moss.

The plants are sent by railway, by steamer, and by the Post Office as parcels. The railway carries the plants free of cost; the Royal Mail Company carry, at present, at reduced rates, and we have hopes that when this Company has larger coasting steamers, it will be possible for them to carry our plants entirely free.

The poorest man in the country has only to send the small sum charged for a plant to the Gardens, and even a single plant is sent perhaps a hundred miles to its destination with as much care as if 10,000 were being despatched to the well-to-do planter.

The question of cost is an important one. At one time it was thought well to give the plants free of charge. It was soon found that this did not work out satisfactorily, as in many cases the plants were not taken care of, simply because they cost nothing. But the cost is reduced to a nominal amount, *e.g.* cacao plants are charged at ½d. a plant in a pot and sweet oranges ¼d. a plant in a pot.

Besides distributing plants, care is taken to issue printed directions for the growth and care of the plants, and the Travelling Instructor supplements this teaching by practical instruction in the fields.

As an illustration of what is being done, I may mention that during a single year (1898-99) the number of citrus plants distributed was as follows :—

Sweet Orange seedlings	—	—	21,201
Grape Fruit „	—	—	16,551
Rough Lemon for budding	—	—	7,200
Sour Oranges „	—	—	5,287
Budded Navel Oranges	—	—	244
Total —	—	—	**50,483**

Of cacao plants 6,000 were distributed, besides 400 selected pods which ought to yield 12,000 more plants.

Of kola plants 12,489 were distributed; 3,000 nutmegs; 1,383 Grape vines; 17,500 sugar cane tops; 3,760 tea plants besides a large quantity of seed.

One hundred pounds weight of tobacco seed was imported from the celebrated Vuelta Abajo district of Cuba, and distributed absolutely free of cost to all who applied for it, on stating the area proposed to be cultivated.

TABLE I.

Return of Economic plants distributed in the island by the Botanic Department, Jamaica, during the years 1879 to 1899.

Plants distributed from 1879 to 1892 ..	110,000
From 1893—1899.	
Nutmegs	26,906
Cacao	28,585
Kola	56,268
Liberian Coffee	75,546
Citrus	218,793
Cane tops	62,736
Ramie	56,921
Rubber	4,067
Tea	22,203
Coffee	18,107
Sisal Hemp	17,714
Grape Vines	1,175
Pine Apple Suckers	4,977
Bombay grafted Mangoes ..	161
Miscellaneous	88,317
Total	795,479

This gives an average of about 40,000 Economic plants distributed per annum.

TABLE II.

Return of Seeds of Economic plants distributed by the Botanic Department, Jamaica, from 1892 to 1899:—

Teak	5	bushels
Liberian Coffee... ...	50	quarts
Blue Mountain Coffee ...	9,500	seeds
Kola	3,902	nuts
Nutmegs	1,572	„
Cacao seeds	12	quarts
„ pods	1,101	
Tea	83	quarts
Sweet Orange	1,000	seeds
Sour „	1,000	„
Rough Lemon	33,000	„
Grape Fruit	50,000	„
Cinchona	56	lbs.
Indigo —	1	„
Tobacco (best Havana) ...	500	„
Divi-divi	6	„

Lignum vitæ ..	A large quantity of each.
West Indian Cedar	
Juniper Cedar ..	
Calliandra Saman	
Erythrina umbrosa	
Tree Tomato ..	

DISTRIBUTION OF ORNAMENTAL PLANTS.

From 1879 to 1892 about	110,000
From 1892 to 1899	159,453
Total -	269,453

or an annual average of about 13,500 plants.

The annual distribution of both economic and ornamental plants therefore exceeds 50,000 per annum.

DISCUSSION.

THE PRESIDENT: Mr. Fawcett has summarized in a striking manner the great usefulness of the Botanic Institutions in the West Indies in propagating and distributing economic plants. I am not convinced that people generally have fully realized the value of this work. It is not too much to say that if we estimate the number and character of the plants distributed, and the accurate and practical information supplied by competent authorities on the spot, the total gain to the community greatly exceeds the annual cost of the Institutions.

As illustrating another department of usefulness for Botanic Institutions reference might be made to the very considerable assistance afforded by the Botanic Station at St. Vincent after the recent hurricane. Mr. Powell, the Curator, has prepared a short paper giving an account of efforts made by him under the direction of the Governor, (Sir Alfred Moloney) and the Administrator (Mr. H. L. Thompson,) to meet the urgent and special requirements in that island in 1898.

DISTRIBUTION OF ECONOMIC PLANTS IN THE ISLAND OF ST. VINCENT AFTER THE HURRICANE OF SEPTEMBER 1898.

BY HENRY POWELL,

Curator of the Botanic Station, St. Vincent.

It will be remembered that a very disastrous hurricane occurred in St. Vincent on Sunday the 11th September 1898,

even more destructive in its nature than "The Great Hurricane of 11th August, 1831," which is still clear in the memory of several persons yet living in the island. The actual time of duration was about five hours, and the lowest reading of the barometer at the Botanic Station (200 feet above sea level) was 28·50 ins., the mercury falling 1·03 ins. in one and three quarter hours. The rainfall during the twenty-four hours was, as nearly as could be estimated, about 13 inches. These data sufficiently indicate the exceptional atmospheric disturbances which took place.

An enormous amount of damage was done throughout the island. In the Botanic Station nearly every tree was badly broken, many valuable and much-prized specimens being completely uprooted and destroyed. The havoc wrought in the forests of the interior was phenomenal and almost incredible. All the leaves, slender branches and even the bark in some instances were completely stripped off. The trees even now look like skeletons of their former selves. The growth recently produced is limited to congested bunches of shoots borne low down on the main branches and stem. The terminal parts are still bare and white. Naturally, cultivated plants such as sugar-cane, cacao, coffee and nutmegs suffered very badly, while the growing crops of "provisions" throughout the whole island were ruined. Immediately after the hurricane hundreds of the country people flocked into Kingstown, and, as the town became congested, relief works were started by the Administrator. A considerable sum was expended in clearing the Botanic Garden and its approaches; also the grounds of Government House and neighbourhood. His Excellency Sir Alfred Moloney, the Governor, arrived in the island by the mail of the 16th September. He had already caused to be forwarded from Grenada a large consignment of miscellaneous plants and sweet-potato vine. The latter was used in planting an acre of land at the Botanic Station, and proved a valuable source whence to obtain supplies for distribution amongst the peasantry.

Large stocks of dwarf French beans and black-eyed "peas" came from St. Lucia and were eagerly taken up by the people. Later, further consignments of potato-vine came from Grenada. These were all sent into the country districts and planted.

A very large supply of Indian corn was requisitioned from Tobago, and arriving early in October was distributed for planting purposes from the various relief centres. From Jamaica came quantities of cassava stems and yam heads. The people were at first somewhat prejudiced against the cassava, owing to it being of a slightly different variety from that usually grown in the island. Most, however, was planted. Her Majesty's ships *Tribune*, *Pearl* and *Alert* brought supplies and the small Royal Mail coasting steamers were invaluable in despatching seeds and plants to the outlying relief centres. By the middle of October the potato-vines had thriven so well in some places that large stocks were available for supplying other districts. Later, sweet potato became so exceptionally abundant that all danger of scarcity of food was at an end.

No opportunity was lost in impressing upon the people the wisdom and necessity of planting the seed and that without

delay. Only a few cases were known of wrongful use of the seed, it being, with very few exceptions, put to the use intended.

The following is a return of the total quantity of seed and potato-vines distributed in connection with the hurricane from the Botanic Station :-

Ears of corn (loose)	18.457 ears
„ „ „ (packed)	7 barrels
Shelled corn	31 bushels
Black-eyed "Peas'	39 „
Red Beans	36 „
Cassava sticks	19 packages
Yams (packed)	11 bags
„ (loose)	135 plants
Potato vines	156 bundles

In order to encourage the growing of other food supplies, cabbage, carrot and turnip seed were obtained in December from John L. Childs' of New York, and distributed in small packets to those likely to make good use of them. Acting on instructions from His Excellency the Governor, I visited the outlying districts and advised the cacao cultivators as to the best methods of promoting the restoration of such trees as could be saved, in the hope of securing a crop the following year. I also encouraged those engaged in rehabilitating their provision grounds, and ascertained to what extent the smaller cultivators had made use of the seed etc. supplied them. These visits were continued during November and December 1898, and the early months of 1899.

My official reports have already been published by the Colonial Office amongst other correspondence relating to the St. Vincent hurricane.

For some time, the cacao growers were very despondent about their cultivation, but the rapid way in which the trees recovered caused them to take heart again, and, during the latter half of last year, planting operations were fully resumed. The supply of plants at the local station proving inadequate to the demands made upon it, the Imperial Commissioner of Agriculture made arrangements resulting in the following welcome consignments amongst others :-

From Dominica Numerous plants and 1½ cwts. of Liberian Coffee berries.

From Grenada 5,000 Arabian coffee plants. These have, been supplied to small holders under the Peasant Proprietary Scheme.

St. Lucia also contributed largely.

The cacao trees at the Station have borne well this season and the best pods are being utilized to raise an extra large stock of seedlings in view of demands likely to arise during the current year.

The following table illustrates the number and character

of the economic and other plants raised at the St. Vincent Botanic Station during the year 1898 :—

Name.	Plants issued free.	Plants sold
Liberian Coffee	3,200	3,240
Arabian „	20	6
Sierra Leone„	53	50
Cacao	9,842	2,588
Nutmeg	895	233
Black Pepper	6	——
Clove	57	70
Cinnamon	11	17
Kola	81	46
Vanilla	12	——
Gros Michel Banana ...	420	——
Orange	254	40
Citron	2	——
Mulberry	81	——
Grape Vine	10	9
Himalayan Raspberry ...	69	7
St. Vincent „ ...	72	——
Jamaica Wild Strawberry ..	147	9
Red Alpine „ ...	24	3
India Rubber	50	——
Eucalyptus	5	——
Melaleuca	1	——
Sapodilla	——	4
Mango	——	2
Ginger	——	100
Mahogany	——	48
Pine Suckers	——	12
Shade Trees	——	36
Miscellaneous	450	538
Totals	15,765	7,058

PACKETS OF SEEDS DISTRIBUTED FREE.

Cabbage	75
Turnip	70
Carrot	70
Tobacco	4
Lettuce	75
Total ...	294

In addition to 12,000 Liberian coffee berries.

THE PRESIDENT: The next paper is one kindly prepared by Dr. H. A. Alford Nicholls who, unfortunately, is not able to be present to-day. In his absence the paper will be read by Mr. Francis Watts.

SUGGESTIONS FOR INCREASING THE USEFULNESS OF BOTANIC STATIONS.

BY H. A. ALFORD NICHOLLS, C.M.G., M.D., F.L.S., C.M.Z.S.

The principal Botanic Stations in the West Indies have now been in existence for ten years. They were established that they might materially assist in restoring the fallen fortunes of these fruitful islands. Several of them, viz., those in Dominica, Grenada, St. Vincent and St. Lucia have become fine botanic gardens, and they have been of great assistance to the planters by supplying them with seedling plants of economic value, and by introducing new plants or new varieties of plants into the various colonies. Other Stations, such as those in Antigua and St. Kitts, have not yet been so successful owing to various causes some unforeseen.

FUTURE OF BOTANIC STATIONS.*

All the Botanic Stations, however, have now entered into a new and happier phase of existence. They are no longer hampered in their work by inadequate funds grudgingly granted for their maintenance; and they are all under the supreme direction of Dr. Morris, the Imperial Commissioner of Agriculture—whose efforts to regenerate these islands years ago brought the Stations into being, and who naturally will leave no stone unturned to ensure their success.

When the Stations were established they were expected to help to introduce new agricultural industries into these colonies and to assist in rendering existing products of the soil more profitable. But I believe that, by striking out in new lines and by an extension of present plans, they can exert far greater influence for good on planting enterprise in the future than they have done in the past. The matter is, of course, one to be determined by executive authority alone; but, in this assembly of what I may describe as the intellectual aristocracy of West Indian agriculturists and educationists, it is right and proper that such an important question should be fully discussed.

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* Note added:—A Botanic Station, as distinct from a Botanic Garden, is usually a smaller establishment chiefly devoted to raising and distributing economic plants and assisting in the development of local industries. The officer-in-charge of a Botanic Station is a Curator, while the officer-in-charge of a Botanic Garden is a Superintendent. The higher title of Director is reserved as in Jamaica, Ceylon &c, to an officer in Executive charge of several establishments forming a recognised Department of Government. [Ed. W.I.B.]

SUGAR CANE EXPERIMENTS.

A large number of those present here to-day are engaged almost entirely in working for the ultimate prosperity of the sugar cultivation in the West Indies and British Guiana. They have already done some splendid work, and they have laid the foundation of further work that will, it is hoped, result in the sugar cane flourishing in these colonies in the future as it has done in the past. Under such men as Professors Harrison and d'Albuquerque, and Mr. Bovell, the experimental station in Barbados has placed itself at the head of those establishments formed for the improvement of the sugar cane and its cultivation. And the reports on the experimental plots attached to Skerritt's school in Antigua have enabled Mr. Watts to make a reputation for himself and the Colony in the application of scientific processes to the sugar industry. In Barbados and Antigua, (as also in British Guiana,) the sugar cane receives most attention, and others can speak best of what can and should be done in the future to push on such scientific work in these Colonies. I propose, therefore, to confine my remarks to matters affecting what are called "new," "secondary," or "minor" industries; but what are, in some of the islands, really the staples on which the fortunes of the people are likely to depend.

NEW INDUSTRIES.

It appears to me that sufficient effort has not been made to introduce new industries that may take the place of cane cultivation in some of the islands, and that may supplement that cultivation in others.

In official reports, in government despatches, in speeches in the Imperial Parliament and the local legislatures, and in the press both in the West Indies and at home, the establishment of "new industries" in these islands has been a constant theme. Had as much time and energy been thrown into the fostering of these new cultural industries, as has been expended in writing and speaking about them, the prosperity we all so much desire would doubtless by now be within measurable distance. But no amount of writing and speaking will induce planters in these islands to start new cultivations simply as experiments. Indeed, considering the general financial embarrassment of the people, brought on by the overwhelming wave of depression that has passed over the West Indies, it can scarcely be expected that the planters can venture to embark in undertakings that, from want of technical knowledge or by reason of other causes, are likely to turn out unsuccessful. What is required, therefore, is to demonstrate by actual results that the cultivation of certain crops, in certain West Indian climates and soils, will give a margin of profit instead of a dead loss. And herein lies, it appears to me, the true and the best work of the Botanic Stations. The mere introduction of a few plants of any particular kind into an island, and a paragraph or two directing attention to them and their uses published in annual reports, are not sufficient. The plants may flourish in a Botanic Station under the skilful management of its Curator and his trained assistants, but that fact does not demonstrate

to the people that the plants, if cultivated by the acre on average soil in various situations, will do well and give remunerative returns.

It is of little use to take the ordinary planter of the islands to the corner of a garden and to show him a plant, and then to tell him to "put in" several acres of it as it is likely to give a profitable crop. He will naturally ask: What will it cost per acre to bring it into the bearing stage? What must I expend in harvesting the crop? How much produce per acre can I depend on reaping? Have you made a shipment of it to the open market? And, if so, show me the account sale? If you cannot answer all these questions satisfactorily, the planter will shake his head, and perhaps he will tell you: "I can now hardly make both ends meet. My property is mortgaged, and I am nearly ruined. My London merchants will not advance money to me for experiments; and, even should they offer such an advance, I would be foolish to run further into debt by accepting it. Your advice to me to engage in this new industry might prove excellent, but it might prove otherwise. In my situation therefore, ordinary prudence renders it necessary for me to abstain from experiments that entail considerable outlay as they might lead to my utter ruin." It appears to me, gentlemen, as I feel certain it also appears to you, that a planter in such circumstances would be perfectly right in adopting such a resolution. It would be far better for him to go on trying to "make both ends meet" than to take steps that might plunge him and his family into the ruin he has staved off by incessant hard work and rigid economy.

ANTIGUA AND ST. KITTS.

Antigua and St. Kitts are eminently adapted to the cultivation of the sugar cane as Mr. Watts can tell you, and it is to be hoped that they will still continue to be "sugar islands." Their inhabitants, however, are now desperately poor, and the establishment of other industries side by side with cane cultivation would be a boon to the islands, the government and the people. To my knowledge, within the last fifteen years, attempts have been made to introduce new industries into these islands; but, owing to misdirected efforts, or by want of technical knowledge, they have failed.

There are now no resident men of wealth able to devote capital to further experiments on these lines, and thus all such enterprises are at a standstill.

EXPERIMENTAL CULTIVATIONS.

For the future welfare of these islands I urge such experiments should be made. But, who is to make them? A satisfactory answer to such question is not far to seek. Such important work—if carried to a successful termination—will, I am satisfied, do as much good to the agricultural interests of the islands as any other scheme conceived for their regeneration. It is therefore, it appears to me, the proper task of the Department of Agriculture to set to work without delay to inaugurate these experiments. The best machinery possible for the work exists

in the Botanic Stations, and in all the islands the local governments can provide the land if the Stations are insufficient in area. The first thing to be done is carefully to consider what is already cultivated in each of the islands, and what new cultivations are likely to prove successful in them. Then let there be laid out experimental plots of those plants selected for trial. The plots must be sufficiently large to afford definite results from which may be demonstrated, without any element of error, the fact that the plants will, or will not be suitable for extensive cultivation in the island. Should an experiment *fail* after a fair trial, much will be gained: for planters will then know to a certainty that the plant in question will not pay to grow. Should, however, an experiment *succeed* much more will be gained, for then the planter will have had an object lesson in the cultivation of what has been demonstrated to be a paying crop suitable to both soil and climate.

EXPERIMENTAL PLOTS.

In the prosecution of the experiments the following rules should be rigidly observed:

(1) The experimental plots should be of not less than an acre in extent, so that reliable estimates can be made on the acreage that may be planted later on.

(2) Most careful accounts should be kept of the expenditure in preparing the land, in planting, in the cultivation, in reaping the crop and in packing it for exportation, so that accurate statements can be drawn up to show the outlay and the profit or loss.

(3) The produce should be shipped to the open market through some commercial firm, so that the result in money return will correspond with that to be got by any one who may later on embark in the new cultivation.

(4.) The results obtained, and all details of the cost of the experiments, should be published for the information of the people who would then have reliable figures to work on.

(5) The experimental plots when laid out, should form the subject of a leaflet or pamphlet to be widely published, in order that the attention of the people generally may be directed to the matter.

(6) When any particular operation in connection with the experimental plots is about to be taken in hand, notice thereof should be published in order to permit those who are interested to attend.

By the adoption of such a plan, in a few years most valuable knowledge would be at the command of all the people; and doubtless, by prosecuting varied experiments industriously and systematically, before long the Agricultural Department would be in a position to demonstrate to expectant planters that by engaging in certain new cultivations there would be more than the promise of ultimate success.

DOMINICA, GRENADA AND ST. LUCIA.

In Dominica, Grenada and St. Lucia there is perhaps less

urgency for the adoption of the plan, for in these islands some of the misnamed "minor" cultivations are well established and by them a dawning prosperity has been brought about. In Dominica and, I believe, in some of the other island Stations, small experimental plots have already been laid out but the plants grown are those that are known to the people and that already exist under cultivation. What is required is to experiment with plants that promise to give profitable returns and that are little known to the people. Thus, Mr. Watts with his usual foresightedness, some years ago wrote and spoke concerning the success that should attend the cultivation of oil-yielding plants in Antigua; but, I believe, nothing has been done in the way of experiment to demonstrate to the people that such staples could and should be added to the island exports.

MOUNTAIN BOTANIC STATIONS.

In mountainous islands like Dominica and St. Lucia, the high lands are still practically untouched by human industry, and yet they are capable of growing a diversity of products; and of supporting in comfort, if not in affluence, a large population. In such islands, therefore, a small hill garden should be opened at which experimental plots could be laid out in cultivations suitable to the mountain climate and soil. The land would cost nothing as the greater part of the higher zone is Crown property; and, by proceeding on a small and economical scale, there need not be great expenditure of money. In this connection it should be remembered that Europeans can labour and live in health in the mountains of the Lesser Antilles. In Dominica, at an elevation of 2,000ft. above the sea level, the average temperature is below 70°F., and there is no malaria. A few young Englishmen have already come out to settle in the island, and they are doing well. Were the natural advantages, the pleasant climate and the healthiness of the mountain lands of the West Indies made generally known, European settlers would doubtless soon be attracted to the islands. But these mountains lands are still covered with virgin forests, and in some of the islands they are unknown except to a very few adventurous persons. They form an extensive undeveloped estate of the Crown; and, in order to bring about their development experimental cultivations conducted on the spot are necessary,—hence the importance, in any complete scheme adopted for the regeneration of these islands, of the establishment of mountain Botanic gardens. At the last Agricultural Conference I strongly advocated the establishment of such hill gardens or stations, and the opinions on the subject I then gave expression to have been strengthened by wider knowledge and fuller experience.

PREPARATION OF AGRICULTURAL PRODUCE.

Another matter that might well engage the earnest attention of the Department is the question of the preparation of produce for the market. In those islands in which there is a peasant proprietary, a very large sum of money is annually lost to the agriculturists by the low price obtained for the

produce in consequence of the sale of badly prepared crops. This is more especially the case in regard to cacao, for much fine "wet" cacao - that should fetch good prices when fermented and dried is sold at the lowest rates in consequence of ignorance and carelessness in its preparation.

MUSEUMS OF ECONOMIC PRODUCTS.

Much might be done to overcome such evils by the formation, in the Botanic Stations, on a modest and inexpensive scale, of Museums of Economic products. In these Museums should be exhibited the various products in all stages of preparation. And, besides the properly prepared product, there should be shown the ordinary ill-prepared one, so that the differences in each could be easily seen and understood. Suitable packages for each product should also be exhibited or figured, care being taken to select such packages as are best liked in the markets.

MACHINERY.

And, again, in those islands where there is a peasant proprietary there should be exhibited small and inexpensive machines used in preparing such products as coffee, essential and other oils, maize &c.

As an illustration of the utility of such a plan, I may point out that a considerable quantity of excellent maize is grown on the windward side of Dominica. The small crops are reaped and the cobs are laboriously shelled by the peasant proprietors and their children with their hands, and the corn is then brought into Roseau for sale. But, as the preparation of the produce by kiln-drying is utterly unknown to the people, their uncured maize gets mildewed and eaten by insects in a short time, and so it is often sold at a very low price as it will not keep, whilst American corn which has been kiln-dried is imported constantly. In this instance the use of a small hand corn-sheller, that would cost only a few shillings, would save a great waste of time and labour; and a few object lessons in drying the corn by a simple process would doubtless lead to its adoption, thereby greatly enhancing the value of the product and driving the imported article out of the local market to the great advantage of the people.

AN AGRICULTURAL LIBRARY.

Finally, I would suggest that there should be attached to each Botanic Station a small Reference library, of works on agricultural subjects, to be thrown open to the public. This is really a great need that could be easily supplied. Most of the Curators already possess a number of books that have been purchased for their official use, and they are in the constant receipt of reports, bulletins and other publications from botanical and agricultural establishments in various parts of the tropical world. Many of the planters would often be most glad at times to refer to works on agricultural subjects, but they do not possess the books and they have no means of obtaining them. The expenditure of £20 a year by each Station on works of reference would, before long, enable a most useful

library to be formed which would be of great benefit to the official staff as well as of undoubted utility to the agriculturists of the islands. Very likely, too, were such a library established at each Station, many additions would be made to it by the gifts of spirited residents.

It will be seen, from these remarks, that what I advocate is the wide dissemination of knowledge on planting matters in all these islands. That knowledge, however, must be practical as well as theoretical, and above all, it must be exact.

It is not enough to exhort the people to study scientific agriculture, and to tell them to do this and to do that. They must be taught by object lessons and by experience gained in the cultivation of crops in their own isolated districts. Most of them are sceptical of the so-called "new products," because they know that persons have tried to grow them and have failed; and they do not, or cannot, put down the failure to the misdirected efforts of uninstructed persons. The people must see the plants cultivated and brought to the bearing stage, and the crops reaped and sold, and they must be satisfied by unmistakeable evidence that profit has resulted, before they will embark in the industry.

One of the most paying cultivations now existing in Dominica is that of the lime. The lime tree thrives and gives good crops in all parts of the island up to an elevation of 1600 feet above the level of the sea. But it was not until the late Dr. Imray who was the greatest benefactor the island ever had was seen to be making money out of the produce of the lime tree, that his advice and assistance in extending the new industry were accepted. From Dr. Imray's action started the regeneration of Dominica. From the work of the Imperial Department of Agriculture we hope to see the regeneration of the West Indies generally.

DISCUSSION.

THE PRESIDENT: Dr. Nicholls is well known as the author of "Tropical Agriculture", and one who takes a deep and practical interest in efforts to benefit these Colonies. At Dominica new industries loom large because, as Dr. Nicholls rightly states, they are "the staples on which the fortunes of the people depend." Limes, essential oils, cacao, coffee and oranges are Dominican products, that are already exported to the value of about £50,000 per annum. The Botanic Station in this island is one of the most promising of any in the West Indies. The distribution of economic plants has averaged about 40,000 per annum. This work alone is most valuable in assisting local industries. How far this and other Botanic Stations can undertake the experiment and sample cultivation suggested by Dr. Nicholls will depend on the amount of land and the funds available in each case. I am heartily in sympathy with the general trend of his remarks. Many points mentioned in the

paper have already received attention and I know I can fully rely on the active co-operation and support of the Curators who in many cases have so long and so strenuously striven to render the Botanic Stations of service to all concerned. When the Agricultural Schools, with their special series of experiment cultivations, are started, as also the local or sample plots in the country districts, under the charge of the Agricultural Instructors, I have every reason to hope that all reasonable assistance in cultivating and curing new products will be within reach of all classes of the community.

OBSERVATIONS ON PACKING AND TRANSPORT OF PLANTS, FRUITS AND SEEDS.

BY J. H. HART, F.L.S.,

Superintendent, Royal Botanic Gardens, Trinidad.

To insure the successful packing and transit of any commodity, it is first necessary to be certain that the material to be sent is in a fit state to be packed. Plants, fruits and seeds are no exception to the rule.

In the first place, a plant should be well rooted, well established, not overgrown, nor too small. It should be clean and free from injury and disease (parasitic insects or fungi) and should carry a certain number of foliage leaves.

A fruit should be full grown or mature, but not fully ripe, free from bruises of any kind. The stalk should not be pulled out, but clean cut. The exterior of the fruit should be perfectly dry.

Seeds should be freshly gathered, not kept in hand longer than actually necessary.

The following are a few of the various methods recommended for packing plants, fruit and seeds.

PLANTS.

The art of packing plants consists in maintaining their vitality uninjured, while in the packed state, and in securing them from damage during transit.

The best appliance in which to enclose plants which have to be sent long journeys is the Wardian case. This may be briefly described as a glass-roofed, wooden box of any required dimensions.

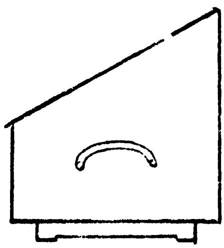
Plants in the tropics are nearly always in a growing state, and, excepting bulbous plants, they can seldom be packed in a resting condition. There are some plants, however, such as agaves, orchids, cacti, &c., which travel well, if packed in dry shavings, in a well ventilated, ordinary, packing case. Roses and plants of like character, coming from a temperate climate, are best packed in the autumn in the resting condition, but

they should have sufficient moisture in the packing about the roots to sustain growth when they reach the high temperature and humidity of the tropics.

The Wardian case is primarily intended to preserve the vitality of growing plants by affording them sufficient moisture, light, and air. This is effected by constructing the case in a certain manner, thus keeping up a regular supply of moisture for the use of the plants. Plants in Wardian cases are given only sufficient ventilation to prevent the interior temperature reaching an excessive height.

There is considerable variation in the form adopted by different packers in constructing their cases. I have prepared diagrams of three of the most common forms: –

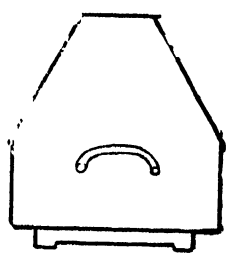
No. 1 has a roof sloping one way only; No. 2 has a gable roof with a flat, boarded top; while No. 3 has a sharp pointed gable roof. No. 1 is the cheapest, No. 3 the most expensive. No. 1 is the cheapest, because it is of very simple construction, but it has several disadvantages. It does not allow much head room, and from its form it offers a tempting seat to the lounging passenger, resulting in broken glass and damage to its contents. It is of the utmost importance that the glass of a Wardian case should be kept intact, otherwise, the contents are liable to serious injury from drought, sea-water, rats, mice, &c.; in fact, the main object of the case is destroyed, when the glass is broken.



No. 1.

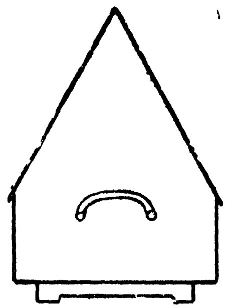
The form of case I have called No. 1 does not permit of easy handling without upsetting: for, if lifted by the handles, one side is found to be heavier than the other, and the case turns a somersault. A well packed case, however, should be capable of being turned completely upside down without injury. The condensation, which takes place on a glass roof with one slope, will of course be delivered on one side of the case only, and thus the packing material around the roots on the higher side of the case will be gradually deprived of its moisture and the plants on that side will suffer. This case is not nearly so strong as Nos. 2 and 3.

The chief advantage of No. 2 is that it gives a larger amount of room for the same "ship's measurement" than No. 1, but it has the serious disadvantage of having a flat top. This flat top condenses moisture, and the water accumulates on the smooth surface of the wood in large drops, and these, instead of running down on the inside of the glass, as in Nos. 1 and 3, fall into the centre of the case, and, if they happen to be delivered full on the stem of any plant that plant is very likely to be killed



No. 2.

before the end of its journey. No. 2 when carried on deck, also admits of use as a seat.



No. 3.

The third form of case is that generally used by the authorities of the Royal Gardens, Kew, and it is in the writer's opinion better suited to the transport of plants for long distances than either of the others. The condensed moisture of the interior is equally distributed by the sloping glass roof.

The only fault attached to this case is that by "ship's measurement", taken to the pointed apex of the roof, it has more cubic contents than Nos. 1 and 2, but this is probably more than compensated for by its not affording a deck seat. This case has an advantage over No. 1 in that its centre of gravity is much lower, reducing the risk of turning over when handled.

Wardian cases should always be packed under cover, the plants should be ready some time before, and should be in that condition known to cultivators as "damp" (i.e. neither in want of water, nor too wet.)

Cleats should be arranged in the interior of the longest side of the case, having notches one inch deep and some three or four inches apart, into which cross bars should fit when the plants are all in place. The packing material should be light in weight and somewhat absorbent, such as leaf-mould, peat, or cocoanut refuse. As the plants are placed in the case, this material should be packed neatly around the pots and rammed firm with a rod small enough to enter all the interstices. When finished, the surface of the packing should be level and the rims of the pots just covered with the packing material. Clay pots, the new metallic pot, or pots of bamboo may be used. When plants are turned out of pots, each plant should be tied up in sacking into a solid ball before packing. No plant should ever be placed loosely into the packing of the case. It is better to place the plants regularly in rows lengthways, and when the packing is finished, or while it is proceeding, some coarse straw or dry twigs should be placed between the rows and these will keep the packing firm when the bars are in place. The bars, one inch square, should cross the box from side to side fitting into the notches of the cleats. A similar cleat with notches will now take the ends of the cross bars nearest the packer, and, being well pressed down, should be screwed or nailed securely. The cleating should be sufficiently strong to prevent the packing from moving, even if the case is turned upside down with considerable concussion. The packing being finished, it is well to sprinkle the interior of the case with a little water, but great care must be exercised in this matter, as too much or too little may mean the destruction of the plants. The best plan is to pack the case two or three days before it is required for despatch, and to close it up when seen to be in exactly the right condition. This condition however is one

which only the experienced eye can secure, and cannot be described.

All Wardian cases should be glazed with rough plate glass, but if clear glass is used it should have a coating inside of white paint, to keep out direct light. The glass roof should be protected by cleats of wood of sufficient strength, placed at intervals which will not allow corners of other packages to break the glass. It has been stated that a great deal of the safety of the plants in a Wardian case consists in having the glass unbroken. If this unfortunately happens, the breakage may be temporarily repaired by pasting a parcel label, or piece of light cloth, over the fracture; this will often save a valuable lot of plants from irreparable injury. It is a good plan when shipping plants to put a notice to this effect on the case. I have always found ships' officers willing to attend to such a trifling matter if it is brought to their notice. On one occasion I observed a captain regularly superintending the washing of decks near a large case of valuable plants, in fact, he looked after it better than the owner.

Plants sent from the tropics to the temperate zone should only be despatched when there is no danger of cold weather on the voyage. For many years the Trinidad Department has arranged to send plants to Europe and America only during the summer months, as it had been found that ninety per cent. of the failures were due to having to pass through a low temperature Hence all our arrangements are made for June, July, August and the early part of September.

Plants coming to the tropics from hot houses in temperate climates can only be sent with certain safety during these months. Occasionally they may come through with safety at other times, but there is always the chance of their getting a cold snap in the Channel, or on a railway platform, or wharf, which may seriously injure or destroy them.

Orchids in their growing stages should always be sent in Wardian cases, but if resting or dried they may safely be sent in ordinary closed cases, packed loosely in dry wood shavings, and well ventilated by small openings, covered with perforated zinc to keep out rats, mice &c. The chief point in packing plants of this class is to support them with the packing, at the same time allowing sufficient ventilation to prevent fermentation, or mould fungi accumulating on the tubers or leaves. If packed in large cases, plenty of struts or bars should be nailed in the cases stretching from one side to the other to take off the weight of the plants, and not allow them to press too heavily one upon another. Orchids are best sent immediately after flowering.

Filmy ferns (species of *Trichomanes* and *Hymenophyllum*) are best sent in tight cases (even tin lined cases may be used), packing the plants between layers of soft damp moss, so as to form with the ferns a soft, wet, spongy mass all through. Many lowland ferns from wet districts, such a *Danaea* and *Marattia*, will also go well by this method, but ferns, as a rule, must be in Wardian cases.

A case of filmy ferns sent to Kew, as above described, during the past year reached that establishment in excellent condition.

In packing plants from the open ground, for local transport, care should always be taken to water copiously before taking them up, so that they may contain a large amount of moisture, and their vitality be better preserved during transit.

Care should always be taken to prevent the exposure of the roots of any plant to dry air or sun, as a few minutes will often do an immense amount of harm.

FRUIT.

My first experience of packing fruit for ocean transit was in October, 1873. In that year, I sent a box of Nova Scotia apples from that country to England. I ventured to mention at the time to Dr. Masters " I think Nova Scotia bids fair to become the apple-producing country of the future." How far this has been realised is within the knowledge of many who have seen these apples in the English market. My consignment was a successful one; Dr. Masters reported: "They were packed in coarse sawdust and came to hand almost without a bruise." These apples were among the first, if not the first, sent to England from Nova Scotia. To-day the trade is of considerable dimensions. I mention this to show that by good packing much may be done in the way of exciting interest in new productions in suitable markets.

Some people hold that only valuable goods are worthy of good packing, and that cheap things will not pay to pack well. Such arguments are fallacious. So far as my own experience goes, whatever is worth packing at all is worth packing well, for even if the packing costs more than the article itself it should nevertheless be put upon the market in the best possible condition. Cheap and ineffective packing is dear at any price. It is clear that it is better to expend 20 per cent. on packing, rather than lose 40 per cent. or 50 per cent. of the returns owing to defective packing. West Indian orange growers have been heard to say : " We cannot afford to pack the same as the Mediterranean people." The reply is clear. " Then do not expect to get a market for your goods." There can be little doubt that in the fruit trade the profit comes chiefly in the economy with which the packing is carried out. By economy, I do not mean cheapness. There is economy in effectiveness, as well as in cheapness. It is certainly false economy to pack *fully ripe oranges* in barrels for cheapness.

With fruit, as with plants the material must be in good order. It will never pay to shake down the oranges from the tree to the ground, carry them for miles in a cart and then shunt them into a barrel. Success can never attend such handling, for all fruit must be handled as carefully as eggs. A blow that would crack an egg, will certainly destroy a fruit; and if such fruit is packed, no matter how carefully, it will assuredly arrive at its destination in bad order. To secure arrival in good condition all fruit must have been carefully gathered, and, without exception, treated in the most careful manner to prevent bruising.

Fruit also requires certain treatment previous to packing, to assist in securing safe transit. This treatment is what I would call "hardening." No fruit should ever be packed when freshly gathered, but how long it should remain must be learnt by experience, as a great deal depends upon the state of the weather. Oranges should be picked at least three or four days before packing, and laid out in single layers until all the moisture, or what is known as the "sweat" of the fruit, has disappeared. To pack fruit when wet or damp, is to court certain failure. The full details of packing are too long to include in a paper of this kind.

There is one point in connection with temperature which must be taken into account. If fruit, such as bananas are kept at too low a temperature they become "chilled" and will rot before they will ripen. It has been frequently stated that to carry fruit successfully, it is necessary to use ice chambers. I believe this idea to be a mischievous one, and it has hindered in no little degree the problem of the safe transit of fruit. The Jamaica No. 11 mango was safely sent to England from Jamaica in 1873, when the transit took 21 days from port to port. In 1875, and again in 1891 the mangosteen reached home from Trinidad in good condition. In no case, was cold storage used. Apples which reach the West Indies in ice vessels, if packed near the ice are valueless for flavour, while those brought over in well ventilated packages, stowed properly in a cool part of the ship arrive in excellent condition, and keep their flavour for a great length of time.

The exact degree of temperature suitable for the cold storage of fruit is not sufficiently well understood. Some people take it to be at or near freezing point, while others adopt temperatures of say 40 or 50° Fah.. This latter, I believe, would be a good temperature for fruits grown in a temperate climate, but if we are dealing with tropical fruits it is probably too low. Cold storage at freezing point may do for dead meat, &c., but it is not suitable for the preservation of fruit. Still, we must have *cool* storage, and how to obtain the desired temperature, must be decided by ship owners and by shippers of fruit.

What is required is a well ventilated hold, maintained at a certain minimum temperature which should be some 10° or 15° below that at which the fruit matures. Fruit will stand considerable hardship, provided it is carefully gathered, well dried and well packed. It is not easy to say, however, which of these three conditions is essential. If a fruit is bruised in the picking, it is inevitably doomed to rot. If not carefully dried, it will almost as surely ferment and rot, and if squeezed or heated in the packing, it must arrive in a bad condition.

The best cases for packing oranges are those furnished with trays admitting one layer only, with bars to take the weight when set on end. A very good and serviceable case is one having a capacity of two cubic feet and divided in the centre. In a barrel the lowest row has to sustain the weight of all

those above it, which may amount to something like three to four pounds per orange. *The continued use of the barrel for oranges and similar fruit helps to bring our beautiful West Indian fruit into grave discredit.*

The package of pine-apples, has to be conducted on the same principle. They should never be packed in barrels but in light crates, each fruit having a separate compartment. Small and indifferent fruits are rarely worth shipping and if in abundance should be preserved or sold locally.

Mangoes can be safely sent, if picked in the condition known as "full," so as to gradually ripen during transit. In this case, it is also necessary to separate the individual fruits, and high class fruit should be packed in the manner adopted for apricots and peaches by European growers, namely in single compartments with soft packing material.

The actual business of packing fruit is an art which only practice can perfect and most of the failures are due to imperfect knowledge of the conditions which are necessary to success.

A common idea exists that cultivators can, by planting at certain times of the year, get fruit such as mangoes and pine-apples to ripen at certain seasons. This may sometimes be possible, but I am of opinion, after a quarter of a century's experience, that the control which can be exercised by the grower over the time of ripening is small, and cannot be depended upon for successive seasons. If we could control wet and dry weather, in the same way as under glass cultivation, something might be done; but until we are in a position to do this, the mango and pine-apple season will be in June, July and August, the coffee crop will come in November and December, and cacao will ripen in June and November, with variations of dates in accordance with the season.

There is great need for study of the possible means to get a crop of fruit out of season, for fruit out of season is well known to pay. I think however that more success will come, if the attack is carried on from a different direction. It is true that we might by withholding water imitate the dry season, and by giving water imitate the wet season; but still uncontrollable differences would yet remain, for it is clear that we could not control the state of the atmosphere surrounding the branches even if we kept the roots dry, and we could not give the dry air coincident with the dry season, during rainy weather, and if we kept a plant well watered, its branches would still be affected by the drought.

The best means to obtain the end in view, would be to seek plants which ripen earlier or later than the general crop, and by selection obtain varieties which come in extremely early, or conveniently late and thus meet the demands of the "out of season" markets. Selection of this kind is carried out in Europe and America, and might equally well answer in the tropics if a little attention was devoted to the subject.

I have digressed somewhat from packing and transport of fruit but, I must plead the excuse, that we must know how to get our fruit before we can pack or transport it.

SEEDS.

Some people are under the impression that the Botanic stations maintain seed shops, where any kind of tropical seed can be purchased in the same way as from seedsmen in temperate climates. It is not so. There are very few tropical seeds indeed, which can be safely kept for more than a month, a great many which cannot be kept more than a week, and not a few whose vitality is destroyed in one or two days if not properly cared for. Thus, a seed shop under European conditions for tropical seeds is impossible.

Tropical seeds possess for the most part a very fugitive vitality, and are easily destroyed by an excess of either drought or moisture; but more quickly by the former. Even if left exposed to air, the humidity of which is generally high, they suffer largely, but if in a position where the alternations of dryness and humidity can affect them, they are destroyed in a very short time.

Proper methods have therefore to be devised to keep them in a suitable state until they reach their destination.

Such seeds as mango, cashew, nicker beans, some palms &c., can stand a large amount of hardship and will keep for a long time, and may be packed in bags or boxes for transit. It is quite a different matter, however, with seeds of *Artocarpus*, *Brosimum*, *Amherstia*, *Castilloa*, *Hevea*, *Cynometra* &c., &c. Such seeds must be preserved in a suitable medium to keep them in good condition and preserve them for any length of time either in hand or on a journey. The best medium found so far, is the fine dust or short fibre from the interior of the cocoanut, commonly called cocoanut refuse. This material is the lightest that can be employed and answers well for almost any kind of seeds. It is especially suitable for packing in tins for transmission by post.

Another material which has been successfully used is weathered charcoal dust. New or unweathered charcoal dust is just as bad for packing seeds as weathered dust is suitable, on account of its caustic character and the amount of moisture it will absorb from seeds packed in it. A danger with both materials is, that spores of certain fungi get into them and destroy the seeds they cover.

Packing for delicate seeds should not be too dry or too wet, but a happy medium between the two, just sufficient to prevent the seed losing moisture and insufficient to start it rapidly into growth. On the whole it is better that seeds should germinate on the way than be kept too dry, provided the process of growth does not reach beyond a certain stage.

Experience teaches that greater success is met with if seeds are started on their journey as soon after harvesting as possible, and not kept a day longer than is necessary. If only required for home use, they are best sown as soon as possible after being gathered.

There is another danger to which even the hardiest of our seeds are subject, and that is, the attacks made upon them by ants, weevils, and other small insects. Seeds which have suf-

fered in this way are often to all appearance perfectly sound, but a close examination will generally show that the germ or growing part has been entirely destroyed. The seed is therefore useless.

Persons living in temperate climates, with no experience of the tropics, can hardly believe that seeds cannot be dealt with in the tropics as in temperate climates, viz, gathered, cleaned and placed in a "dry drawer" until required. Proof that imported seeds will not keep is to be found in the universal complaint of the bad quality of the seeds which are on sale. Many trials of freshly imported seeds have been made at Trinidad. As a rule, they have been found to be good on arrival, and to lose vitality exactly in proportion to the time allowed to elapse since they were imported.

Peas, which on first arrival showed a germination of 98 per cent., kept for one month in a dry drawer will have their vitality reduced to 40 per cent. and in three months' time not 10 per cent. will germinate. Other kinds of seeds are affected in a similar way. If the period of test, however, happens to be in the dry season, vitality will be found to be more persistent.

These facts were recognised many years ago and have been met, by ordering periodical supplies at frequent intervals. Seeds can be kept for a greater length of time if they are imported in packages which have been sealed in dry air in the temperate zone and only unsealed as required. The best packages for seeds are small tins opening readily with a thumb piece, like Huntley and Palmer's biscuit tins, or the tins used for packing Capstan tobacco.

Continental seed-men adopt new methods quicker than English traders. The latter do not appear to exert themselves to keep the West Indian trade.

The transport of seeds should always be made by the quickest route and by parcel post, where possible. Consequently they should be put up in light and handy packings.

SUMMARY (*a*) PLANTS.

1. Always select healthy and well-established plants.

2. Use dry well-ventilated cases for orchids, cacti, bulbs, &c.

3. Pack filmy ferns, mosses, &c., in damp moss in closed cases.

4. Pack plants in growth, or likely to come into growth, in Wardian cases, well battened down, and see that the case contains the proper amount of moisture before finally closing.

5. Adopt the safest case, and ventilate sufficiently.

6. Take precautions to minimise risk of injury during transit; in particular guard against excessive illumination, drought, displacement and movement of packing material, breakage of the glass, changes of temperature, and damage from salt water, animals, etc.

7. When packing plants for short distances, it is sufficient to protect the roots and prevent rapid evaporation.

(*b*) FRUIT.

8. Pick the fruit when mature, but not over-ripe.

9. Let the fruit stand some time before packing so as to ensure a hardened surface and freedom from moisture. Handle it as carefully as eggs.

10. Pack so as to prevent movement and bruising, but do not squeeze.

11. Pack in small cases, *not in barrels*, and use cheap and light packing material.

12. Do not allow fruit to travel in too high or too low a temperature.

13. To obtain supplies of fruit out of season, select early and late varieties.

(*c*) SEEDS.

14. Transport all tropical seeds as soon as harvested.

15. Keep seeds secure from attacks of ants and weevils.

16. Pack short lived seeds in damp cocoa-nut fibre, or *weathered* charcoal refuse.

17. Ship always by the shortest route.

18. In the tropics import packages of European seeds in airtight cases, and open as required.

[NOTE ADDED.]

Extract from "Gardeners' Chronicle," No. 674 -Vol. XXVI., November 25, 1899.

INFLUENCE OF DRYING UPON THE GERMINATION OF PALM SEEDS.

Seeds of *Oreodoxa regia* sent dry, packed in capsules of paper, did not germinate till after the lapse of one year and a half; whilst seeds sent in moist wood charcoal germinated in a few weeks after sowing. Comparing results, it was evident that out of about forty species of palms, only three or four species germinated when the seeds were sent over here dry, and of these only a few seeds; whilst almost all the seeds of nearly all the species germinated when the seeds had been packed in a moist medium, and arrived in a moist state. —*Dr. Udo Dammer, Gross Lichterfelde, near Berlin.*

BEE-KEEPING IN JAMAICA.

BY JAMES DOIDGE.

Lecturer in Bee-keeping to the Agricultural Society of Jamaica.

Modern bee-keeping in dovetailed hives, with moveable frames, may be said to have been introduced into Jamaica about five years ago. Previous to this period a few improved hives, called the "Simplicity," were imported; but very few, if any, were successful. Great impetus was given to modern bee-keeping in Jamaica by Mr. George Nash of Mandeville

who started the first large modern apiary in dovetailed hives, in the parish of Manchester about 4 years ago.

Through the exertion of this gentleman, as a member of the Board of Management of the Jamaica Agricultural Society, queen-bees were admitted through the post—although the Post-master of Jamaica opposed it when first appealed to. I wrote on the subject to the Post-master General of the United States complaining that queen-bees sent me from different parts of America had been returned to the senders by the Post-masters of New York city and Boston. In reply he wrote me that if the postal authorities of Jamaica would receive them he would issue orders accordingly. On receipt of this letter Mr. Geo. A. Douet, Secretary of the Jamaica Agricultural Society, brought it under the notice of the Governor, Sir Henry Blake, whose prompt reply was: "Certainly, Mr. Douet, orders will be issued at once to admit queen-bees through the Post-office." Now, hundreds of pure Italian queens are imported from the States at a cost of from one to five dollars each. Before proceeding further with this paper, I beg to be allowed to bring to the notice of the Imperial Commissioner of Agriculture for the West Indies that a dreaded disease called "foul brood" is very common in Cuba and orders should be issued that no queens or bees be allowed to be imported into any of the West Indian Islands from that country. On this point I beg to refer the Commissioner to page 446 of Langstroth "On the Hive and Honey Bee" and especially to the wood-cut on page 448 taken from T. W. Cowan of London, the greatest living authority on the diseases of bees. As soon as we succeeded in being allowed to import queens into Jamaica our next task was to get bee-supplies placed on the free list of imported goods. This was taken up by the Hon'ble R. B. Braham, Member of the Legislative Council for Clarendon. He placed the matter before the Colonial Secretary, the Hon'ble F. Evans, who promised to place bee-supplies on the free list in the bill he was then preparing. This bill passed without objection, so bee-supplies will remain free of import duties for the next six years. A sketch of the history of bee-keeping in Jamaica would not be complete without mentioning the firm of Hooper Brothers. They are Apiarians of long standing and importers of bee-supplies as well as myself. Two years ago they produced 100 casks of honey of 400 lbs. each from 200 colonies of bees—that is, the honey produced during the first year was worth as much as the apiary that actually produced it. The great advance in modern bee keeping in Jamaica during recent years is largely due to Mr. Geo. A. Douet, Secretary of the Jamaica Agricultural Society. It was he who saw the possibilities of this branch of rural industry and brought it prominently before the Society who gave a grant of £50 to pay the expenses of a Lecturer to go over the Island and give demonstrations in every parish on modern bee-keeping. A second grant of £50 was afterwards given for the same purpose. Mr. Douet accompanied the Lecturer to the parishes of St. Thomas, Portland, St. Ann's, St. Andrew's, Trelawny, St. James, Hanover, Clarendon, Westmoreland and Kingston. On account of sickness Mr. Douet was unable to accompany the Lecturer to St. Elizabeth. Lectures have also been given in Manchester, but

the Lecturer being a member of the Central Manchester Agricultural Society these lectures were given under the auspices of that Society at Mandeville. In reply to the question, does modern bee-keeping pay? I say, Yes and No. It pays well, if well managed. It will not pay if carelessly attended to. My bees have paid from 35 to 75 per cent. on their first cost. A lady in Vere, in Clarendon parish, last season produced over 10,000 pounds of extracted honey. She had only been in the bee-business a little over 18 months. Several times she became discouraged, but, being a plucky little woman, she was determined to go on "for one more season." Ultimately she extracted over 10,000 lbs. from 30 colonies of bees. I may mention that a "colony" of bees is a brood nest and as many "supers" or surplus boxes as may be needed. This lady used as many as five "supers". She lives in an ideal location mangrove on one side with logwood and other honey-producing plants and trees on the other. I claim for this lady and Jamaica the largest average crop of honey from a given number of hives produced anywhere in the world. In regard to the difference between the results obtained from the old box hives and those from moveable frame hives, during one of my lectures at Montego Bay I asked all present to hold up their hands who had ever kept hives on the old "turndown-box" plan. Many held up their hands. I then asked one old man to state for the benefit of the audience what he considered a good average crop for one hive. He replied "One and a half gallons, Sir". This is equal to about 21 lbs. of honey. I asked a young bee-keeper from Port Maria to state the best crop from one improved hive he had produced. His reply was "A little over 400 lbs., Sir". This crop was produced from a "12-frame hive" and a good strain of Italian bees. I consider an average crop of 112 lbs per colony for the whole apiary a very fair average. Of course the location, the quantity of honey-yielding plants in the neighbourhood and, above all, good management with good queens are all factors that must not be neglected. I hope in the near future to be able to prepare a list of honey-yielding plants in Jamaica. Several bee-keeping friends in different parts of the island are already helping me in this direction. As soon as it is completed, I hope to submit it for revision to the Director of Public Gardens and Plantations who, long ago, promised to give me the colonial as well as botanical names. This will be a valuable contribution to bee-keeping, not only in Jamaica but in the West Indies generally. Bees will pay on a coffee or any fruit-producing plantation even if they never give a pound of honey or wax. I know of a coffee estate that gave 105 bags of full, clean coffee; while the light coffee did not fill a bushel. The reason of this was not far to seek. There were on this plantation 150 colonies of Italian bees, with 50 to 80,000 bees in each, and for the two days when the coffee was in flower these hard toilers visited every bloom on every tree several times. I once marked a certain flower and stood watching it for an hour, and I saw five bees visit it during that time. Bees, it is well known, gather honey and pollen at the same time. A gentleman in Westmoreland (Jamaica) has invested in bees believing that they will greatly improve his

pimento crop. The orange, lime and citrus crops generally would be very greatly benefitted by the addition of a few colonies of bees in their neighbourhood.

I may add that Jamaica "extracted honey" is fast gaining a name in the markets of Europe. Again, our bees-wax is always quoted at about 10/- to 12/6 per cwt. higher than any other wax sold either in the London or any of the Continental markets.

[NOTE ADDED.]

The following table, kindly furnished by the Hon'ble James Allwood, Collector-General, illustrates the value of the Exports of Honey and Bees-wax from Jamaica during the years 1888 and 1898 respectively:

HONEY.

1888.				1898.			
Countries.	Value.			Countries.	Value.		
	£	s.	d.		£	s.	d.
To United Kingdom	1,315	2	0	To United Kingdom .	1,164	0	11
„ United States America	25	11	0	„ United States America ..	938	19	10
„ Foreign States	3	8	0	„ Germany .	21	2	10
Total	£1,344	1	0	Total ..	£2,124	3	7

BEES-WAX.

1888. Countries.	Value.	1898. Countries.	Value.
	£ s. d.		£ s. d.
To United Kingdom	4,772 17 6	To United Kingdom	9,147 15 6
„ United States America .	49 17 6	„ United States America	1,046 7 8
		„ Canada	23 10 2
		„ Germany	119 14 0
		„ Bermuda	38 10 0
		„ B. West Indies	12 16 8
Total	£4,822 15 0	Total	£10,388 14 0

It is evident from the above tables that during the ten years from 1888 to 1898 the value of honey exported from Jamaica has increased from £1,344 to £2,121; and that during the same period the value of bees-wax exported has increased from £4,823 to £10,389.

The total export of both honey and wax has therefore increased from £6,167 in 1888 to £12,513 in 1898, or more than doubled during that period.

Some share of this increase is no doubt due to the intelligent action of the Jamaica Agricultural Society in employing Mr. Doidge and its admirable Secretary (Mr. George Douet) to make periodical visits to country districts and to encouraging a better system of caring for the bees and recovering honey and wax.

LEGISLATION SUGGESTED FOR THE TREATMENT OF INSECT AND OTHER PESTS AFFECTING ECONOMIC PLANTS.

DISCUSSION.

THE PRESIDENT: At the last Conference Mr. Fawcett read a paper on the prevention of the introduction and spread of fun-

goid and insect pests. He pointed out that when we grow plants of one kind on a large scale, they are specially liable to be attacked by disease which may not only destroy them but cause ruin to the planters. He instanced the case of the coffee leaf disease in Ceylon, and the many insect pests that have attacked crops in various parts of the world. Mr. Fawcett recommended: (a) that all nurseries and Botanic Gardens should be periodically inspected by a Botanist and Entomologist and, where necessary, all infected stock should be destroyed; (b) that a Law should be passed in every Colony in the West Indies empowering the Governor to prohibit the importation of seeds or plants from any country on reasonable grounds of the possibility of infection. In the course of the discussion following Mr. Fawcett's paper, it was stated that the injury done to crops by insect and fungoid pests was apparently increasing, that thousands of pounds were in consequence annually lost to cultivators and in some localities there was danger that one or two industries would have to be abandoned altogether. In order to give practical effect to the opinion expressed last year, the Secretary of State has approved of the appointment of an Economic Entomologist on the Staff of the Imperial Department of Agriculture. That officer has already entered upon his duties. Further, an important despatch (dated the 3rd October 1899) has been addressed by the Secretary of State to the Governors of the West Indian Colonies recommending "measures which it might be possible to take for the double purpose of checking, and, as far as possible, eradicating existing diseases and preventing them being communicated from Colony to Colony in the West Indies, or being introduced into the West Indies from other countries." This despatch, and other correspondence bearing on the subject, has been printed and is already in your hands. It would be useful to point out that in the case of insect pests already in a country, in process of time a balance appears to be established and, although present, they do not always cause serious damage. On the other hand, in the case of new introductions, it often happens that the pest acquires great vigour under new conditions and serious injury is done to crops. This so generally happens that it has been assumed that where excessive damage is done by an insect pest, that pest is of foreign origin. Whether we can be entirely successful in our efforts to keep out certain insect and fungoid pests remains to be seen. There can, however, be no doubt as to the duty imposed upon us to keep a watchful eye on the possibilities of such introduction and give timely warning of the dangers to which crops may be exposed. My object now is to invite discussion and obtain the opinion of this Conference as to What is, and What is not, possible to be done to meet the circumstances of these Colonies. The points which might be usefully discussed are as follows:—

(1) Is Legislation necessary to prevent the introduction of insect and fungoid pests from Colony to Colony in the West Indies or into the West Indies generally from other countries?

(2) If such Legislation is necessary, would it meet requirements, following the example of Jamaica and Trinidad, to em-

power the Governor by proclamation to prohibit from time to time the importation of certain plants, portions of plants or seeds, from certain places to be specially named ?

(3) Where total prohibition, as indicated in (2), is not desirable, would it be possible to organise a system of inspection of plants, cuttings, etc., by competent officers, at the ports of landing? Healthy plants might be admitted, under a system of quarantine, but those seriously diseased should be immediately destroyed

(4) As an alternative to (3) would it be possible to rely on a certificate, given by the person shipping the plants and countersigned (as in Queensland) by the Department of Agriculture, stating that the plants are from a healthy stock (that is are free from diseases) or, that before shipment, they had been disinfected under official control?

As Mr. Fawcett introduced the subject at the Conference last year I would ask him to be good enough to open the discussion to-day.

Mr. Fawcett : I have not prepared notes on this subject to place before the Conference, but I would take the opportunity of saying a few words with especial reference to Jamaica. In Jamaica we have found it necessary to obtain legislation giving the Governor general power to prohibit the importation into the Colony of certain seeds and plants. We have since gone further, and the importation of certain citrous plants (oranges etc.) is only allowed at one port, namely, Kingston, after inspection by a Government officer. For some plants, as for example coffee, there is absolute prohibition, with the single exception that the Government Gardens may import a special variety of coffee, but only through the Royal Gardens at Kew.

As a further precaution a system of quarantine is imposed. Citrous plants, which are very liable to attack by scale insects, are dealt with in this manner at the port of entry. In addition to inspection I am of opinion they should undergo fumigation with hydrocyanic acid, which, properly applied, would probably destroy both insects and eggs. The plants should be kept in quarantine under the observation of a competent officer, preferably an Entomologist. It is recognized that mere inspection on landing is not in itself sufficient.

The President : How would you propose to deal with a large importation of cane plants ?

Mr. Fawcett : I have not considered that question, but I should be very loth to allow the indiscriminate distribution of cane plants from one Colony to another. At the last conference I obtained 200 tops of B. 147, which, on arrival at Jamaica, were found to be very badly infested with borer and other diseases. They were in consequence destroyed. I am of opinion it is dangerous to introduce large quantities of cane plants without some guarantee that they are free from disease.

The President : In British Guiana at the present moment, owing to severe drought, the planters have lost a large number of their young plants. They cannot replant without introduc-

ing cane-tops in considerable quantities from other colonies. Would you prohibit importation in such a case, or rely on inspection only ?

MR. FAWCETT: I really do not know what to advise. The cane tops might be fumigated or steeped in some solution which would kill the insects. There should also be careful official inspection. Certificates from the place of shipment are open to suspicion and cannot be depended upon.

THE PRESIDENT: Fumigation might be useful with growing plants, but cane-tops are difficult to deal with. The use of a solution for steeping the tops would possibly be more effective. In Queensland, oranges, before they are exported, are fumigated and a certificate, issued by the Department of Agriculture, is accepted in the other Colonies as a guarantee that the fruit is not likely to cause the spread of injurious insects.

MR. HART: Before we legislate to prevent the introduction of a pest into a Colony we must be certain that the pest is not already present. Hence it would be advisable to legislate only for certain recognized diseases, which are unknown in the Colony in question. Fumigation may do for some insect pests, but I am doubtful as to its efficacy in the case of fungoid diseases. Personally I should support measures for (1) inspection, (2) fumigation, and (3) in the last resort, of total prohibition, provided these can all be carried out without unduly interfering with legitimate trade.

MR. QUELCH (British Guiana): Whilst an Ordinance authorizing prohibition in cases of emergency is desirable in British Guiana, it is open to question whether it would be of such value there as in the smaller West Indian Colonies. The mainland of South America already contains so many pests, both native, and introduced forms of world-wide distribution, that I fear we have almost as many diseases as could possibly be introduced. At the same time, I do not think we should prevent, or seek to minimize effective steps which may be of service elsewhere. We must also bear in mind that pests which attack one plant in one locality, may attack others if introduced elsewhere.

With regard to the question of inspection, whilst it would probably be effective in the case of small consignments, I should not like to say with certainty that it would necessarily be of service or practicable with large consignments of plants, or, say, with shiploads of cane tops.

REV. DR. MORTON (Trinidad): This subject is closely connected with that of dealing with pests already existing in the Colony. We are troubled in Trinidad with numerous pests and now we have a new one—the West Indian Dodder (*Cuscuta*)—probably introduced during the last few years. It first made its appearance in the neighbourhood of Port-of-Spain, and rapidly spreading to the villages of the interior, soon became a great nuisance. Mr. Hart and myself moved in the matter, hoping to check its progress, but the Government had no powers to deal with the particular case. I believe the Governor of each Colony should have power to order the destruction

of trees or plants infested with dangerous pests. With regard to imported plants there should be powers of inspection, and, if necessary, total prohibition. I do not think that mere inspection at either the shipping port or the port of entry would alone be sufficient. To be effective there should be a quarantine for observation of all plants after importation.

PROFESSOR CARMODY (Trinidad): This subject has already been discussed at the Agricultural Society in Trinidad, and the planters, as a whole, are, I believe, opposed to any system of quarantine involving detention at the port of entry. I advocate powers to follow up plants after entering the Colony; the destruction of plants only being enforced when disease has proclaimed itself. We should in my opinion demand a clean bill of health from the port of shipment, and a guarantee from the owner of the estate from which the plants have come, countersigned by some official with local knowledge, that the estate is free from disease.

SIR GEORGE PILE (Barbados): I should suggest that cane tops required for shipment, for instance from Barbados to other Colonies, be inspected by a competent officer in the field before they are cut. This would save expense and loss to the estate, and also enable the officer concerned to see exactly the condition of the canes from which tops are to be taken. There should be little or no doubt afterwards as to the healthiness of the tops. They might still be inspected at the port of entry to satisfy local requirements.

THE PRESIDENT: We have had a very useful discussion on the points placed before the Conference, and it should not be difficult to recommend legislation to meet immediate requirements. As regards pests already established, or in course of establishing themselves in these Colonies, I am strongly of opinion that the local Government should have general powers to deal with each case as it arises. The *Cuscuta* pest referred to by the Rev. Dr. Morton as causing concern in Trinidad, is also spreading in Grenada. In this and similar circumstances, it might be useful that action be taken on the lines adopted in the Straits Settlements in dealing with beetles in the cocoa-nut palm. The cocoanut industry was threatened with serious injury, if not extinction. The Government passed a law requiring all persons possessing cocoa-nut palms, in such a diseased condition as to become a source of danger to neighbouring plantations, to cut down and destroy such trees. If this was not done within a certain time, the Government undertook the work and charged the expenses to the owners. The law has been in operation for several years, and I understand it proved successful. The work was entrusted to the Department of Gardens and Forests. I recommend that copies of the Law above referred to be obtained from the Government of the Straits Settlements, together with any papers and reports issued on the subject. I quite agree that the best way to encourage good cultivation is to protect the careful planter from the results of the careless action of his neighbour. We may pass now to measures for keeping out and protecting ourselves from pests known only in other countries. This can only be done by regulating and controlling the intro-

duction of seeds and plants from infected sources. I am of opinion that it is desirable in the first place to recommend a "Plant Protection Law" giving general powers to the Governor, with the advice of the Executive Council, to issue a Proclamation, as occasion requires, prohibiting the importation into the Colony of plants, seeds, berries, and other articles, affected, or suspected to be affected with disease, from a certain country or countries. "The Seeds and Plants Importation Law, 1884" passed in Jamaica appears to me likely to meet the circumstances of most West Indian Colonies. It has already, I believe, been adopted in the Leeward Islands. Under this Law (as will be shewn later) the importation of seeds or plants may be prohibited absolutely from certain countries; or they may be imported subject to inspection at the port of entry, and, if infected, "they shall thereupon be destroyed."

In Queensland "The Diseases in Plants Act of 1896" is intended not only to deal with the importation of plants but also with plants already under cultivation in the Colony. The owner of an orchard in Queensland affected with disease is served with a notice requiring him, within a given time, to take measures to eradicate the disease: (1) by destroying all fallen and decayed fruit, by boiling, or burying them "beneath not less than one foot six inches of solid earth;" (2) by spraying his trees (according to the nature of the disease) either with a "resin wash for scale insects" or "sulphur, lime and salt wash" or "Bordeaux mixture." If we are to deal effectively with insect and fungoid pests, it is absolutely necessary that the Government of these Colonies should have powers somewhat analogous to those indicated above. If the planters in a democratic community, like that of Queensland, are willing to submit themselves to restrictions of a more or less stringent character to protect their crops there should be no serious difficulty in adopting similar restrictions, when circumstances actually demand it, also in the West Indies.

APPENDIX.

Secretary-of-State to the Governors, Barbados, British Guiana, Jamaica, Trinidad, Leeward Islands, Windward Islands.

Downing Street.
3rd October, 1899.

SIR,

My attention has been drawn from time to time to the losses sustained by planters in the West Indies, owing to the prevalence of disease of various kinds in the sugar canes and other economic products, and to the danger of such diseases being spread and increased by the introduction of diseased plants from elsewhere; and at the recent Agricultural Conference at Barbados the question was the subject of some discussion.

2. Legislation has been passed in some Colonies for the purpose of prohibiting the importation of certain seeds and

plants from particular countries affected by special diseases, such as the Ceylon coffee leaf disease, but no system has been adopted in any of the West Indian Colonies for the supervision of the introduction of economic plants so as to check, and, if possible, prevent the importation of diseased specimens.

3. I have taken advantage of Dr. Morris' presence in England to consult him as to the measures which it might be possible to take for the double purpose of checking, and, as far as possible, eradicating existing diseases, and preventing their being communicated from Colony to Colony in the West Indies, or being introduced into the West Indies from other places.

4. With regard to the first of these objects the difficulties, as I understand, which the planters have had to contend with hitherto are two fold, firstly, the difficulty in some cases of identifying the specific nature of the disease itself, and secondly, the want of expert advice as to the proper treatment to be applied for its eradication.

5. Specimens of diseased plants or of insect pests have occasionally been sent to this country for examination, but while such specimens are naturally on their arrival here not so suitable for examination as they would have been on the spot, the time lost in such a reference may be of serious consequence, nor would it be possible to meet the difficulty to any but a very small extent in this way.

6. I have therefore come to the conclusion that there should be some officer in the West Indies possessing the requisite expert knowledge, whose duty it should be to advise the Government, as also individual planters and others, on this subject, and to deliver lectures from time to time under the direction of the Commissioner of Agriculture. It is accordingly proposed to appoint an Economic Entomologist who will be on the staff of the Imperial Department of Agriculture, and whose salary and travelling expenses will be charged to the Imperial grant for that Department. The services of this Officer will in the first instance be available for the West Indies generally, but, should the demands upon his time hereafter prove more than he can meet, it will be necessary for the Governments of the larger Colonies, viz: British Guiana, Jamaica and Trinidad, to provide for their own requirements in this respect.

7. With regard to the second object in view, viz: the supervision of the importation of economic plants, it appears to me that a system of inspection might be devised under which all imported plants should be inspected by an Officer of the Government (who might be the Director, Superintendent, or Curator of the Botanic Gardens) before being removed; and further that in the case of all plants passed by the Inspector, with the exception of plants intended for the Botanic Station, the address of their destination should be taken, and the plants kept under observation for so long as might be considered necessary. Plants intended for the Botanic Gardens might be at once taken to their destination and placed for a certain time in a special quarantine ground reserved for this purpose, where they could be kept under observation and apart from other plants in the Botanic Gardens.

8. In any Colony where no legislation has as yet been passed giving the Government power to prohibit, when desirable, the importation of any particular seeds or plants from any particular countries, the opportunity might be taken to include such a provision in the proposed legislation, otherwise such legislation would only refer to growing plants and not to seeds or fruit; and I would suggest that drafts of the proposed legislation should be referred to the Commissioner of Agriculture for the sake of his advice, and with a view to securing uniformity so far as may be possible.

9. I have not gone into any details as I should desire you to consider the suggestions which I have made in connection with local circumstances, which must necessarily vary in different Colonies, and I shall be glad if after full consideration and consultation with the Commissioner of Agriculture and with any other persons in the Colony whose opinions would be of value, you will inform me of the action which you consider it desirable and practicable to take in the Colony under your Government on the lines suggested.

10. I need hardly impress upon you the great importance of this question in Colonies such as the West Indies, which are almost entirely dependent upon Agriculture.

11. I have communicated a copy of this despatch to Dr. Morris.

I have, etc.,

(Sgd.) J. CHAMBERLAIN.

JAMAICA.

JAMAICA LAW 4 OF 1884.

The Seeds and Plants Importation Law, 1884.

[31st October, 1884.]

Preamble,

Whereas it is expedient to take precautions against the introduction into this island of leaf and other kindred diseases in plants, and with that view to empower the Governor by Proclamation to prohibit the importation of seeds, plants or soil, either altogether, or from such country or countries, or except on such conditions, as he may see fit:

Be it enacted by the Governor, with the advice and consent of the Legislative Council of the Island of Jamaica, as follows: -

Power to Governor by proclamation to prohibit or restrict the importation of seeds or plants, &c.

1. It shall be lawful for the Governor from time to time, by Proclamation to be published in *Jamaica Gazette*, to prohibit the importation of seeds, plants, or any description of earth or soil, or any article packed therewith, that may have come either directly or indirectly from any country that may be named in such Proclamation; and also in like manner to prescribe the conditions under which alone the importation of

any articles aforesaid shall be permitted that may have come either directly or indirectly from any country to be named in such Proclamation, the importation from which is not absolutely prohibited; and any such Proclamation as aforesaid from time to time to revoke or vary.

2. Any of the articles aforesaid coming as aforesaid from any country the importation from which is for the time being prohibited, and any of the articles aforesaid arriving as aforesaid from a country the importation from which is allowed upon conditions only, until and unless such conditions shall have been complied with to the satisfaction of the Principal Officer of Customs at the port of arrival, shall be deemed to be prohibited goods within the meaning of the Laws relating to Customs; and any such conditions aforesaid shall be deemed to be restrictions within the meaning aforesaid.

Such pr[illegible] ited art[illegible] to be dee[illegible] to be pro[illegible] ted good[illegible] and cond[illegible] tions to deemed trictions, der the [illegible] tom Law

3. So long as any Proclamation as aforesaid is in force, any of the articles aforesaid coming from parts beyond the sea may be deemed to have come from a place the importation from which is prohibited as aforesaid, and may be treated accordingly, unless the Importer satisfies the Principal Officer of Customs at the port of arrival to the contrary.

Onus pro[illegible] di as to p[illegible] from wh[illegible] articles a[illegible] imported

JAMAICA LAW 25 OF 1891.

A Law in aid of the Seeds and Plants Importation Law, 1884.

[27th May, 1891]

Whereas it is apprehended that leaf and other kindred diseases in plants may be introduced into the Island otherwise than by means of seeds, plants, earth or soil, or articles packed therewith, introduced into the Island from a Country named in a Proclamation of the Governor issued under Law 4 of 1884, and it is expedient accordingly to pass a Law in aid of the said Law 4 of 1884:—

Preamble

Be it enacted by the Governor and Legislative Council of Jamaica, as follows:

1. It shall be lawful for the Governor, in and by any Proclamation issued or to be issued under the Provisions of the said Law, to prohibit the importation from the Country named in such Proclamation of any particular goods, packages, coverings, or other articles or things, to be named in such Proclamation, which in his judgment are likely to be a means of introducing diseases in plants from the country to which such Proclamation applies.

Power to prohibit t[illegible] importati[illegible] of any goo[illegible] packages, coverings, &c.

2. Any goods, packages, coverings, articles or things, named under the Provisions of this Law in any such Proclamation shall be subject to all the provisions of the said Law applicable to seeds, plants and other things, named in any such Proclamation under the provisions of the said Law.

Prohibited packages, goods, &c., subject to Law 4 of 1884.

3. This Law and Law 4 of 1884 shall be read and taken together as one Law.

Law of 18[illegible] incorporated.

8. In any Colony where no legislation has as yet been passed giving the Government power to prohibit, when desirable, the importation of any particular seeds or plants from any particular countries, the opportunity might be taken to include such a provision in the proposed legislation, otherwise such legislation would only refer to growing plants and not to seeds or fruit; and I would suggest that drafts of the proposed legislation should be referred to the Commissioner of Agriculture for the sake of his advice, and with a view to securing uniformity so far as may be possible.

9. I have not gone into any details as I should desire you to consider the suggestions which I have made in connection with local circumstances, which must necessarily vary in different Colonies, and I shall be glad if after full consideration and consultation with the Commissioner of Agriculture and with any other persons in the Colony whose opinions would be of value, you will inform me of the action which you consider it desirable and practicable to take in the Colony under your Government on the lines suggested.

10. I need hardly impress upon you the great importance of this question in Colonies such as the West Indies, which are almost entirely dependent upon Agriculture.

11. I have communicated a copy of this despatch to Dr. Morris.

I have, etc.,

(Sgd.) J. CHAMBERLAIN.

JAMAICA.

JAMAICA LAW 1 OF 1884.

The Seeds and Plants Importation Law, 1884.

[31st October, 1884.]

Preamble,

Whereas it is expedient to take precautions against the introduction into this island of leaf and other kindred diseases in plants, and with that view to empower the Governor by Proclamation to prohibit the importation of seeds, plants or soil, either altogether, or from such country or countries, or except on such conditions, as he may see fit:

Be it enacted by the Governor, with the advice and consent of the Legislative Council of the Island of Jamaica, as follows: -

Power to Governor by proclamation to prohibit or restrict the importation of seeds or plants, &c.

1. It shall be lawful for the Governor from time to time, by Proclamation to be published in *Jamaica Gazette*, to prohibit the importation of seeds, plants, or any description of earth or soil, or any article packed therewith, that may have come either directly or indirectly from any country that may be named in such Proclamation; and also in like manner to prescribe the conditions under which alone the importation of

any articles aforesaid shall be permitted that may have come either directly or indirectly from any country to be named in such Proclamation, the importation from which is not absolutely prohibited; and any such Proclamation as aforesaid from time to time to revoke or vary.

2. Any of the articles aforesaid coming as aforesaid from any country the importation from which is for the time being prohibited, and any of the articles aforesaid arriving as aforesaid from a country the importation from which is allowed upon conditions only, until and unless such conditions shall have been complied with to the satisfaction of the Principal Officer of Customs at the port of arrival, shall be deemed to be prohibited goods within the meaning of the Laws relating to Customs: and any such conditions aforesaid shall be deemed to be restrictions within the meaning aforesaid. Such prohibited articles to be deemed to be prohibited goods, and conditions to be deemed restrictions, under the Custom Laws.

3. So long as any Proclamation as aforesaid is in force, any of the articles aforesaid coming from parts beyond the sea may be deemed to have come from a place the importation from which is prohibited as aforesaid, and may be treated accordingly, unless the Importer satisfies the Principal Officer of Customs at the port of arrival to the contrary. Onus probandi as to place from which articles are imported.

JAMAICA LAW 25 OF 1891.

A Law in aid of the Seeds and Plants Importation Law, 1884.

[27th May, 1891]

Whereas it is apprehended that leaf and other kindred diseases in plants may be introduced into the Island otherwise than by means of seeds, plants, earth or soil, or articles packed therewith, introduced into the Island from a Country named in a Proclamation of the Governor issued under Law 4 of 1884, and it is expedient accordingly to pass a Law in aid of the said Law 4 of 1884:— Preamble.

Be it enacted by the Governor and Legislative Council of Jamaica, as follows:

1. It shall be lawful for the Governor, in and by any Proclamation issued or to be issued under the Provisions of the said Law, to prohibit the importation from the Country named in such Proclamation of any particular goods, packages, coverings, or other articles or things, to be named in such Proclamation, which in his judgment are likely to be a means of introducing diseases in plants from the country to which such Proclamation applies. Power to prohibit the importation of any goods packages, coverings, &c.

2. Any goods, packages, coverings, articles or things, named under the Provisions of this Law in any such Proclamation shall be subject to all the provisions of the said Law applicable to seeds, plants and other things, named in any such Proclamation under the provisions of the said Law. Prohibited packages, goods, &c., subject to Law 4 of 1884.

3. This Law and Law 4 of 1884 shall be read and taken together as one Law. Law of 1884 incorporated.

THE SEEDS AND PLANTS IMPORTATION LAW.

(JAMAICA.)

H. W. NORMAN.

[L.S.]

By His Excellency Sir Henry Wylie Norman, General of Her Majesty's Forces, Knight Grand Cross of the Most Honourable Order of the Bath, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Companion of the Most Eminent Order of the Indian Empire, Captain-General and Governor-in-Chief in and over the Island of Jamaica and its Dependencies.

PROCLAMATION.

In virtue of the power vested in me in that behalf by the First Section of Law 1 of 1881, entitled "The Seeds and Plants Importation Law, 1881," I do hereby prohibit, until further Proclamation, the importation into this island of Seeds or Plants, or any description of earth or soil or any article packed therewith that may have come either directly or indirectly from any of the following Countries: Natal, South India, Ceylon, Mauritius, Java, and Fiji.

Given under my Hand and the Broad Seal of this Island at King's House, this Second day of December, in the Fifty-first Year of Her Majesty's Reign, Annoque Domini, 1887.

By Command,

(Sgd.) J. ALLWOOD,
Acting Colonial Secretary

HENRY A. BLAKE.

[B.S.]

Preamble,

By His Excellency Sir Henry Arthur Blake, Knight Commander of the Most Distinguished Order of Saint Michael and Saint George, Captain-General and Governor-in-Chief in and over the Island of Jamaica and its Dependencies.

PROCLAMATION.

Power to Governor proclamati[on] to prohibit [or] restrict th[e] importatio[n] of seeds or plants, &c.

In virtue of the power vested in me in that behalf by the first section of Law 4 of 1881, entitled "The Seeds and Plants Importation Law, 1881", I do hereby prohibit until further Proclamation the importation into this Island of orange plants, cuttings, buds or grafts that may have come either directly or indirectly from the State of Louisiana or from the State of Florida in the United States of America, except on the following conditions namely:-

Such plants, cuttings, buds or grafts shall be imported at the port of Kingston only.

Before such plants, cuttings, buds or grafts are delivered, the Officers of Her Majesty's Customs shall inspect them, and if the said Officers have reason to suspect that such plants, cuttings, buds or grafts are affected with scale insect, mealy bug or other parasite, the said plants or portions of plants shall be sent forthwith to the Curator of the Institute of Jamaica for examination, and if it shall be found that such plants, cuttings, buds or grafts are infected, they shall thereupon be destroyed.

Given under my hand and the Broad Seal of this Island at King's House, this seventeenth day of July, in the Fifty-ninth year of Her Majesty's reign, Annoque Domini, 1895.

By command,

(Sgd.) FRED EVANS,
Colonial Secretary.

Importation of Citrus Plants.

Extract from Journal of the Jamaica Agricultural Society, vol. iii p. 706. (Dec. 1899.)

A letter was read from the Colonial Secretary, dated 31st October, in which the Colonial Secretary stated with reference to the Society's letter of the 5th, forwarding one from Mr. R. C. Bennett, asking leave to import Citrus Trees by way of Port Antonio, he invited the Society's reference to a letter of his, dated 20th March last, in which their recommendations were invited on the question of arranging for the inspection and disinfection of Citrus Plants, at Kingston, if their importation were restricted to that port, and he (the Colonial Secretary) would be obliged if the Society would favour the government with their remarks on the matter.

The Colonial Secretary also forwarded a copy of a Memorandum by the Director of Public Gardens recommending the trial at Kingston in the first instance of the method of disinfection known as the gas treatment or "fumigation" by hydrocyanic acid, as explained in the Bulletin, copies of which were forwarded, and to ask that the Society will consider and report on Mr. Fawcett's suggestion, when making the report asked for in the preceding paragraph.

Memorandum by the Director of Public Gardens and Plantations.

Hon. Colonial Secretary: The letter referred to me addressed to the Secretary of the Agricultural Society by Mr. R. C. Bennett, asks for a remission in his favour of the quarantine regulation for plants. I take the opportunity to state my views generally on the subject.

2. When the Government, after due deliberation, have decided to interfere with trade, their purpose is presumably so serious that no infringements, however small, should be allowed.

3.—The necessity for quarantine regulations for plants need not be enlarged upon here, it is universally admitted and acted upon by countries dependent in any large degree upon some form of plant life.

4.—To be effective, however, quarantine regulations should deal with every channel by which plants may be imported. I learn that plants are brought into this country by parcel post without any inspection for pests. This mode of importation should certainly be under the same restriction, and there can be no difficulty inasmuch as all parcels are subject to Customs inspection.

5.—Although strictness in quarantine should be enforced, the Government will doubtless, always be desirous to consider any suggestion which may make the regulations less onerous without losing any part of their efficiency.

6.—In the Bulletin for this Department for August and September in the articles on scale insects, a method of disinfection known as the gas treatment or fumigation by hydrocyanic acid is explained at length.

7. I refer to it as I think that the adoption of this treatment by the Government in connection with the quarantine regulations would make them more easy and simple in their operations and at the same time much more effective.

8.—Inspection of plants for insect pests by an expert is not absolutely certain in its effect, for although it should prevent to a very great degree the importation of such pests, the eggs of some deadly insect may easily escape notice.

9.—Fumigation if properly carried out is certain in its destructive effect, and there is no need for the services of an entomologist for inspection, if all plants without exception are subject to the process.

10. The only requisites are a tight fitting chamber, cyanide of potassium, sulphuric acid and water. The treatment is therefore cheap as well as effective, and could be operated by the Customs officers, on plants landed from abroad, at any port.

11. A small chamber of 20 cubic feet content would perhaps be sufficient for dealing with parcels through the Post Office, but a larger one would be necessary for dealing with the importation *(e.g.)* of 5,000 citrus plants, and this chamber should be provided with a flue, as pointed out on page 118 of the Bulletin.

12.—The treatment might be tried first at Kingston, and if found easy of operation, as I anticipate, the regulations might be modified so as to allow the landing of plants at Port Antonio and other ports.

13.—I beg to enclose the Bulletin referred to.

(Sgd.) Wm. FAWCETT.

It was resolved to reply that the Society agreed with the recommendations of Mr. Fawcett and recommended their adoption, the system of fumigation to be tested first in Kingston.

TRINIDAD AND TOBAGO.

AN ORDINANCE to prevent the introduction of Diseased Sugar Canes into the Colony.

Diseased Sugar Canes. No. 8. - 1890. 12th May.

[L.S.] WILLIAM ROBINSON, GOVERNOR, 30th May, 1890.

BE it enacted by the Governor of Trinidad and Tobago with the advice and consent of the Legislative Council thereof as follows:

1. It shall be lawful for the Governor by Proclamation from time to time to prohibit absolutely the importation into the Colony of any Sugar Canes which shall have been grown in Java, or in India, or in the Colony of Queensland in Australia, or in the Island of Mauritius or any of its dependencies, or in any other place in which it shall be proved to the satisfaction of the Governor that Sugar Canes grown therein are subject to or threatened with infectious or unknown disease, and by subsequent Proclamation to revoke or vary the said Proclamation.

Power to Governor Proclamation, to pr hibit the i portation diseased S gar Canes.

2. From the date of such Proclamation all Sugar Canes which shall have been grown in Java, or in India, or in the Colony of Queensland in Australia, or in the Island of Mauritius or any of its dependencies, or in such other places aforesaid, shall be deemed goods absolutely prohibited to be imported within the meaning of "The Customs Ordinance, 1880," as if the same had been included and described in the Table of prohibitions and restrictions contained in Section Eight of the said Customs Ordinance, and all the provisions of the said Customs Ordinance, 1880, with respect to goods absolutely prohibited to be imported, shall apply to such imported Canes so long as any such Proclamation as aforesaid shall be in force.

The provisions of Se tion 8 of "Tl Customs Or inance, 188(to apply to goods prol bited to be imported u der this Or nance.

3. It shall be lawful for the Governor if he shall so think fit to make such Rules and Regulations from time to time as he may deem necessary for preventing the introduction into the Colony of Sugar Canes grown in any of the aforesaid places which shall be named in such Proclamation aforesaid, and for that purpose, if necessary, to provide for the inspection of all Sugar Canes imported into the Colony and ascertaining where such Canes were grown, and by such Rules and Regulations to impose reasonable fines and penalties for breach thereof, to be recovered in a summary manner before a Stipendiary Justice of the Peace in the name of such Public Officer as the Governor shall appoint for the purpose and in the manner prescribed by, and such Rules and Regulations, when made, shall have effect until the same shall have been annulled or revoked by Proclamation.

Governor may make rules, &c.

Passed in Council this Twelfth day of May, in the year of Our Lord one thousand eight hundred and ninety.

J. CUNNINGHAM,
Acting Clerk of the Council.

AN ORDINANCE to make provision for prohibiting the importation into the Colony of plants, seeds, berries and other articles affected or suspected to be affected with disease.

No. 28.—1894. 27th August.

[L.S.] F. NAPIER BROOME, GOVERNOR, 8th September, 1894.

eamble.

WHEREAS it is apprehended that leaf and other kindred diseases in plants may be introduced into the Colony by means of plants, seeds, berries, earth, packages and otherwise.

And whereas it is expedient to protect the plantations in this Colony against such diseases.

Be it enacted by the Governor of Trinidad and Tobago with the advice and consent of the Legislative Council thereof as follows:

ort title.

1. This Ordinance may be cited for all purposes as "The Plant Protection Ordinance, 1894."

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2. The introduction into the Colony of Coffee plants and uncured berries from Ceylon, Mauritius, Reunion, Fiji, Southern India, Sumatra, Java, Natal, or from such other places as may be included in any Proclamation under this Ordinance, is strictly prohibited.

ower of overnor by oclamation to prohibit importation of lants.

3. The Governor may from time to time with the advice of the Executive Council, by Proclamation to be published in the *Royal Gazette*, prohibit the importation into the Colony of any plants, seeds, berries, earth, soil, or any particular class of goods, packages, coverings, or other articles or things to be named and specified in such Proclamation which there shall be reason to believe to be affected with any disease, or which may be brought from any place outside the limits of the Colony where any such disease may exist or be suspected to exist, or which may be likely to be the means of communicating diseases to plants in this Colony.

oduction *Royal azette* evience.

4. The production of a copy of the *Royal Gazette* containing a copy of such Proclamation shall be sufficient proof of the terms of such Proclamation and the publishing thereof.

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5. A Proclamation issued and published under the provisions of this Ordinance shall be conclusive evidence in all Courts of Justice and elsewhere of the several matters and things therein set forth and contained.

enalty.

6. Any person contravening the provisions of Section 2 or of any Proclamation issued and published under the authority of this Ordinance shall be guilty of an offence against this Ordinance, and on summary conviction before a Stipendiary Justice of the Peace shall forfeit and pay any sum not exceeding Fifty Pounds sterling.

wer to ize prohibd imports.

7. Every article or thing imported into this Colony in contravention of this Ordinance or of any Proclamation under this Ordinance may be seized by any officer of Customs or by any Commissioned or Non-commissioned Officer of Police or Police Constable, and shall be forfeited to Her Majesty, and may be destroyed or otherwise dealt with as the Governor may direct.

8. Penalties under this Ordinance may be recovered before any Stipendiary Justice of the Peace, and the procedure for the recovery thereof shall be according to the Ordinance No. 5 of 1868, entitled "An Ordinance respecting the Summary Administration of Justice," or according to any Ordinance which may hereafter be passed regulating the Summary Administration of Justice. Procedure.

Passed in Council this Twenty-seventh day of August, in the year of Our Lord one thousand eight hundred and ninety-four.

CHAS. J. ROOKS,
Acting Clerk of the Council.

BRITISH GUIANA.

Extract from a letter from the Government Secretary, British Guiana to Imperial Commissioner of Agriculture.

Government Secretary's Office,
Demerara, 13th December, 1899.

Sir,

3. With regard to the broader question of the supervision of the importation of economic plants, there is a concensus of opinion that the suggestions contained in the 7th and 8th paragraphs of Mr. Chamberlain's Despatch will prove of value to this colony, and could, under existing conditions, be carried out by the present staff of the Botanical Gardens, unless importations should largely increase. There is no legislation in this colony of the nature indicated by the Secretary of State. It is understood that several of the West Indian Islands have already made legislative provision in this respect, and it would be of much assistance to this Government if you would furnish a reference to the Ordinance which in your opinion is best suited to the conditions of this Colony, or to any other form of model ordinance which you may have before you.

4. There is one point to which Mr. Jenman has referred which appears to require special attention, and on this question also the Governor would be glad to receive your views and advice. It is with regard to claims which may arise for compensation in respect of losses to the importer by the detention of his goods for examination. In past years considerable quantities of cane tops have been imported in the ordinary course of business for the replenishment of fields. The detention which would be inevitable in dealing with large importations of the kind might possibly, on the occurrence of a change of weather, detrimental to the planter, during the period of such detention, be used as a ground on which to claim compensation.

5. The whole matter is one which you will no doubt take the opportunity of discussing with the representatives of this

Colony during their presence in Barbados at the approaching Conference.

I have the honour to be,
Sir,
Your obedient Servant,
(Signed) CAVENDISH BOYLE.

SUGGESTIONS FOR A PLANT DISEASE ORDINANCE.

PORT OF ENTRY.

To take power to make, by proclamation, certain places "Ports of Entry" for plants; and to prohibit entry at other Ports.

INSPECTION.

To provide for inspection of plants by persons properly qualified, on arrival at Port of entry.

ABSOLUTE PROHIBITION.

To give power to the Governor by proclamation to prohibit the importation of any plant or part of a plant, or seed, or fruit of such plant or any particular class of goods, packages, merchandize, coverings or other articles &c. &c.: from any place or country whatsoever, on sufficient evidence being shewn for the necessity for such action for the protection of the Agricultural interests of the Colony.

POWER TO DESTROY PLANTS &c.

To take power to destroy at once all plants, parts of plants, or seeds arriving from an infected country or proclaimed country, or which can be proved to have been derived from a proclaimed country.

DESTROY OR QUARANTINE WHEN INFECTED.

To take power to destroy all plants condemned by Inspector or to quarantine same for certain periods, and to provide powers for maintaining a proper registry of all imported plants or seeds, persons importing and destination.

FURTHER TREATMENT.

Power should be taken to deal with same pests after introduction, fungoid, insect and plant parasites included, and provide machinery for their destruction when generally hurtful to the Agricultural interests of the Colony.

EXPENSES.

To provide for the payment of fees, for inspection and expenses of quarantine.

PENALTIES.

To provide for pains and penalties, for contravention of Ordinance and for the recovery of same by summary manner.

RULES AND REGULATIONS.

To provide for the making of rules and regulations for the

guidance of importers and Inspectors, and for the recovery of penalties for the infringement of same. Also for the guidance of same when plants are quarantined.

CONCLUSION OF CONFERENCE.

The PRESIDENT : In closing this Conference and releasing you, at the end of a second long day, from your arduous duties I desire to thank you most heartily for the kind and earnest manner in which you have joined in arranging and carrying on the business entrusted to you. I believe that the Conference now closing has been even more successful than the last. We have got through a large amount of work compressed within a short time. The subjects dealt with have been most important as they directly concern the needs and requirements of these Colonies. To those who have contributed papers and taken part in the discussions we owe our best thanks. The papers and discussions will shortly be published in the " West Indian Bulletin" but the best results of this Conference you will. I hope, carry back with you in the conviction that these annual gatherings are essential to the success of agricultural enterprise in the West Indies, and in the renewed life and interest with which, as members of an organised body, you will take up the duties of the coming year.

Revd DR. MORTON : On my own responsibility as a member I should shrink from proposing a vote of thanks but I have been asked, and I count it an honour to do so It is also a very great pleasure to me as a representative of one of the Agricultural Societies in the West Indies, to be asked formally to move a vote of thanks to the President of this Conference. In his opening speech, Dr. Morris said that his labours would be fruitless without our assistance. This may be true but not in the strong way in which he has put it. Still I think we can assist somewhat, and we should be fully determined after a Conference like this, to help the Imperial Department of Agriculture whenever we can, wherever we are placed, and in whatever way we can. Dr. Morris has helped us readily, and has always been willing to help us. For the cordial way in which we have been received, his courtesy and due regard to our wishes, our President has shown himself not only entitled to ordinary thanks, but to a hearty vote of thanks coming from this Conference and from every gentleman connected with it.

Mr. FAWCETT : I have very great pleasure in seconding the vote of thanks to our President. I believe the smoothness with which the work of the Conference has passed, the clockwork system on which it has been got up, the ease with which everything has gone on, and its great success, generally, are entirely due to the great organising power of the President, assisted by his subordinates. We owe them hearty thanks for

the great measure of profit this Conference has been to us. I am not the representative of the Agricultural Society of Jamaica, but I have listened with pleasure to the kind words in which the President has spoken of that Society. I shall on my return convey to the Board of management the high opinion expressed by the President respecting the value of their efforts.

DR. MORRIS in acknowledgement said: I am extremely obliged to Dr. Morton and Mr. Fawcett and the members generally for the very kind way in which my efforts in connection with this Conference have been recognised. I thoroughly appreciate the cordial manner in which you have tendered me your thanks. I am glad also that the considerable labours of those who have assisted me have been so warmly appreciated. Before we part, we ought to pass a cordial vote of thanks to His Excellency the Governor and the Executive of Barbados, for the kindness with which they have placed this Hall at our disposal, and for the many ways in which they have assisted the business of this Conference. I am sure that when the Report of the Conference is published the Secretary of State will be gratified to find that the Department is regarded as working on right lines, and its usefulness is being widely recognised in these colonies. Gentlemen, in wishing you goodbye I trust you will carry back with you a pleasant impression of your attendance at this Conference, and a determination, as Dr. Morton has said, to continue your efforts, and return next year still more resolved than ever to follow on the lines we have so well begun.

The Conference of 1900 then terminated.

MOTH BORER IN SUGAR CANE.

(Diatræa saccharalis, Fabr.)

BY H. MAXWELL LEFROY, B. A.

Entomologist to the Imperial Department of Agriculture for the West Indies.

Wherever sugar cane is cultivated, it is attacked by a number of insect and fungus diseases, some of which have caused a large amount of damage, and are regarded as inevitable features of cane cultivation. Of the insects those that have become epidemic and assumed the rank of serious pests have been studied with considerable care in different parts of the world, and our knowledge of these is increasing year by year. Perhaps the best known and first recorded insect enemy of sugar cane is the moth borer of the West Indies *Diatræa saccharalis*, Fabr. Insects known as moth borers occur wherever cane is grown, and the New World moth borer is represented in other parts of the world by closely allied insects of similar habits. Besides the moth borers, there are a great number of insects that attack cane and it must be admitted that the pests we are acquainted with and whose life histories have been worked out are few in number compared to the pests of minor importance that are to be found in canefields. Dr. Zehntner (81) recently enumerated 85 insects injurious to cane, occurring in Java alone, and the fauna of other localities needs only to be investigated to yield a list of insects and other organisms, which though at present insignificant, are yet potential pests, and which the conditions of cane cultivation may at any time bring into greater prominence

Turning to *Diatræa saccharalis*, the first mention occurs in Sir Hans Sloane's work on Jamaica (1), written early in the 18th century; it is probable that the "worm" there referred to can be nothing but our moth borer, and it is supposed to be the insect described by Fabricius (2) from South America in 1793. In

1828, the Rev. Lansdowne Guilding (4) described the moth borer from St. Vincent, and there is little doubt that his *Diatræa sacchari* was the same as Fabricius' *Phalæna saccharalis*, now known as *Diatræa saccharalis*. In Schomburgk's "*History of Barbados*" (7) will be found a reference to this pest, and about the same year Gosse (6) records it from Jamaica. That a moth borer of some description was at this time to be found also in Mexico is evident from the specimen of cane preserved at Kew, which dates back to 1854, and shows distinct evidence of moth borer attacks (58). In the year 1856, a report on the Cane diseases of Mauritius was published by a Select Committee, (8. 12.) and this deals with a moth borer that is either *Diatræa saccharalis* or *D. striatalis*. In the next year, a disease of sugar cane is recorded from India by B. J. Mookerjee (11), and in his "*Bibliography*," H. Ling Roth (23) adds, "evidently the borer is the cause of the disease."

The same year, 1857, gives evidence of the occurrence of the pest in the Southern United States, (9.42), and some years later, Miss ORMEROD records the occurrence of *Diatræa saccharalis* in British Guiana (18). The moth borer is recorded from the Sandwich Islands in 1883, (21), and two years later, H. LING ROTH (22) finds what he believes to be the same insect in Queensland. There are numerous references to the occurrence of the pest in Florida (40), Mexico (49), and other parts of America, (27.56 etc.), both Cane and Indian Corn suffering from the attack. E. C. COTES (31) in 1889 described a cane borer from India, which was probably Mookerjee's disease, and considered it identical with *Diatræa saccharalis*; in 1892 a specimen sent to Washington was stated by Professor C. V. RILEY and Dr. L. O. HOWARD not to be *Diatræa saccharalis*, but a species of *Chilo* which the condition of the specimen prevented them from ascertaining (54). During the last 20 years, a voluminous literature has grown up in scientific publications and periodicals, and a complete history of the occurrence and ravages of this insect has yet to be compiled. The localities may be provisionally summed up as follow :—The West Indies, Central America, United States, South America (British Guiana etc.), Sandwich Islands, Queensland, Mauritius and India—the last three of these are doubtful.

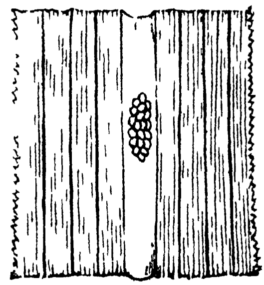
Other species of *Diatræa*, or closely allied genera, occur in other parts of the world. Ceylon, Singapore, Borneo, Sumatra are infested with *Diatræa striatalis* (81): Algiers and possibly the Canaries by *Sesamia nonagrioides*: Celebes, Java, Mascarene Islands, and Madagascar have *Diatræa striatalis* var. *albiciliata* (78.79. 85.). Java in addition has *Chilo infuscatellus*, *Grapholitha schistaceana*, *Scirpophaga intacta* (83.84). Mauritius and the Mascarene Islands have *Sesamia nonagrioides* and *Alucita sacchari* in addition to *Diatræa striatalis* (73.78.79.). *Diatræa* is a genus closely allied to *Chilo*, in which the West India moth borer was for some time placed. There is a considerable amount of confusion in the literature as to the generic and specific names of the moth borers. *Proceras sacchariphagus*, and *Phalæna sacchari*, are two old names for the moth borers of British Guiana and other places (13.18.). There are a number of

species of *Chilo* and *Diatræa*, and a monograph on these and allied genera, with descriptions of the larvæ of all the species known to attack sugar cane, if not existing, would be very welcome.

The great number of other insects that attack sugar cane has already been alluded to. In the West Indies, we find a considerable variety, including the weevil, *Sphenophorus sacchari*, the shotborer, *Xyleborus perforans*, the cane fly *Delphax saccharivora*, the mealy bug *Dactylopius*, and other less well-known insects. Wherever sugar cane is grown, destructive diseases occur, not only insects but also mites and a number of fungoid diseases. Of these some are parasites in the strict sense of the word, others are saprophytes, and in a number of cases it is as yet uncertain whether they are merely followers of the true parasites or do themselves attack growing cane. In the majority of cases, our information is too scanty to allow of a reliable list of parasites and saprophytes being compiled, and it is to be hoped that those interested in the cultivation of sugar cane will endeavour to add to our knowledge by observations of the habits of those pests that trouble them.

2.—The Egg.

The eggs of the moth borer of the West Indies, (*Diatræa saccharalis*), are flattened, oval in outline, slightly convex: they measure $\frac{1}{25}$ in. (1 mm.) in length, and the upper surface is finely reticulate. They are laid in clusters, and are apparently fastened to the leaf by some mucilaginous matter, which remains on the leaf after the eggs have come off. The number of eggs in a cluster is very variable, as many as 57 having been found and as few as four. The number will be found to be usually between 10 and 30; 173 clusters were counted, and they were found to aggregate 3.227 eggs, the average thus being nearly 19 (18.6). The eggs partly overlap one another in a uniform manner, but the arrangement in rows is by no means uniform. As a rule the rows are clearly distinguishable, and are most commonly three in number. About 50 per cent. are laid in three rows, about 20 per cent. in 1 or 2 rows, and the remainder are in five or more rows, or very irregular. Prominence is given to this point because Dr. Zehntner (83-84) uses this character to distinguish the moth borers of Java.



Eggs of *Diatræa saccharalis* on a piece of the leaf of young cane. (Natural size.)

The eggs are laid on the leaf. I have never seen eggs laid elsewhere on the cane, and a point high up on the leaf is usually selected. There is no uniformity in this matter, the eggs being laid on either side of the leaf, at any point in its length and at any spot of the breadth. If the conditions under which the eggs are laid are borne in mind, this is to be expected, as there is often a strong wind blowing across the canefields, which are not sheltered by trees; the moth has therefore to settle when and where she can, being a weak flier. It is in my opinion very

rare to find eggs on dead or withered leaves, even in the old canes. The eggs are laid on the green leaves, and this again is to be expected when the habits of the larva are taken into account. This has a considerable degree of importance in view of the practice of pulling off the trash from growing canes, and will be dealt with later.

A point worthy of consideration is whether a narrow-leaved cane suffers less than a broad-leaved one. It is stated that certain varieties of canes suffer less than others when they are young, and though no certain information can be obtained, it appears reasonable to suppose that varieties with narrow leaves would suffer less, owing to the greater difficulty the moth would have in laying eggs. It appears improbable that the caterpillars could exercise a choice. They eat all varieties. Only the moth could be affected in the case of choice of young canes, and I have seen fields of young canes, grown near patches of mature canes full of moth borer, where the narrow leaved showed a very noticeable absence of dead hearts, as compared with broader-leaved varieties. Such a point can be settled only by extended observation, but if borne in mind by planters, more information may be forthcoming.

The eggs when freshly laid are light yellow in colour; within 36 hours a tinge of orange appears, which deepens gradually; the eggs then become orange-brown, some noticeably browner than others: this deeper colour is associated with the eggs that are laid uniformly in two rows only, and I have endeavoured to satisfy myself whether these might not be the eggs of a distinct variety or species. The small number that survived the artificial conditions of growth appeared, however, to be identical with the rest, and, though I am not thoroughly satisfied, I am of opinion that colour variation in the eggs does occur, and is no guide to distinct varieties or species.

The final stage of the egg is when the centre is black, and the outer edge orange or orange-brown. The caterpillar can then be seen, with a microscope, curled up in the egg. It raises its head, bites or pushes through the thin shell and comes out. The conditions being the same for all the eggs of a cluster, the emergence of the caterpillars is wonderfully simultaneous; in one case the whole of a cluster of 28 hatched out within one minute.

3. THE LARVA.

On hatching, the caterpillars are active and can be seen walking about the leaves. They may let themselves down from the edges of the leaves by a thread, which is produced from the hollow tip of the hypopharynx. In a short time, they disappear, either into the axils of the leaves, between the leafsheaths, or into the tissue of the leaf itself. In the latter case, they mine for a short distance and come out again, eventually reaching the axil of the leaf. They remain in the outer leaf-sheath for about 10 days and increase in size. At first hatching they are $\frac{1}{12}$ in. (2 mm.) in length, of a bright orange colour, with numerous short black hairs.

If at the end of 10 days the shoot be unrolled, the caterpillars will be found eating the outer leafsheaths, their presence being shown by the dust and *débris* they leave. The heart of

the cane is then pierced, most usually at the base, and a part eaten out. If this is done low down the growing point is destroyed as well as the centre leaves. All the centre leaves that are eaten through decay, the portion outside drying up. Such a cane is known as a "deadheart," and the decayed centre affords a home for other organisms, which follow the moth-borer. These are saprophytes which, however, do not destroy any part of the living cane.

So far, I have described the attack on young canes. In canes that have already formed joints, the attack of the caterpillar may not lead to the death of the cane: if the growing point is eaten, the whole cane may die, or side buds may develop into shoots. In the joints the caterpillars make tunnels, which commonly run up and down the cane, but sometimes run round the outside. The caterpillar may come out and go in again elsewhere and is not deterred by the rind of even such a hard cane as B. 147. As in the young cane, the first few days are spent under the leaves, or in the tissue of the leaves. Caterpillars are rarely found under the old leaves unless they are piercing the cane itself, and if fed on old leaves, they die.

When fully mature, the caterpillar eats a hole to the outside; a few threads are spun across this hole, to keep out unwelcome visitors, and the caterpillar turns into a pupa: the head of the pupa is turned towards the opening and the cast skin lies further inside the tunnel. The duration of the larval life in artificial conditions is from 33 to 35 days; in growing cane it may be slightly shorter, lasting from 30 to 35 days.

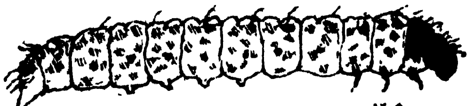
When eggs are laid on a leaf of young cane, there are more caterpillars as a rule than that one shoot can support and very commonly in one hole there will be found two or three deadhearts. As stated above, 19 eggs are laid in one cluster, as an average; in old cane, this number may find food in that cane, but in young canes, a number appear to migrate to other shoots. I am of opinion that these caterpillars migrate when they are at least 10 days old. Some dead-hearts have two holes on the outside, one smaller than the other: apparently the caterpillar has gone in at the smaller hole, and the larger hole is made for the moth to escape by. Such deadhearts are caused by larvæ that have come from another shoot. When one shoot is carefully infected with a number of recently hatched caterpillars, other shoots become attacked also and in some cases, under artificial conditions, shoots of plants in neighbouring pots were found to be attacked, though no eggs were laid on these plants.

The withered centre leaf does not show itself till late in the life of the caterpillar. Of 50 dead-hearts, 18 contained only the empty pupa case, showing that the borer-moth had escaped. There were also 92 larvæ, all far advanced and 18 pupæ, giving an average of over 2 to each dead-heart.

Structure of the Caterpillar. When the caterpillar is first hatched, it is orange in colour, with a flattened black head, a black prothoracic shield, and numerous black hairs. The colour soon changes to a dirty white, and brown spots appear on the skin. The apparent variation of the older larvæ is great, some being much lighter in colour than others, with very faint spots.

Close examination will reveal the presence of the brown spots. Full grown larvæ are whiter than younger ones and this may be due to an increased amount of white "fat-body" under the skin.

A full grown larva is slightly over 1 inch in length. The head is small, rounded, deep brown or black in colour: there is a V shaped light mark on the dorsal surface of the head. The antennae are very inconspicuous, situated in front of the ocelli. There are 6 ocelli, which are difficult to distinguish on account of their dark colour and minute size. The usual three pairs of jointed legs occur on the thorax, and prolegs on abdominal segments 3 to 6 and at the hind end of the body.



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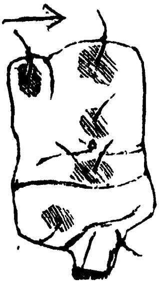
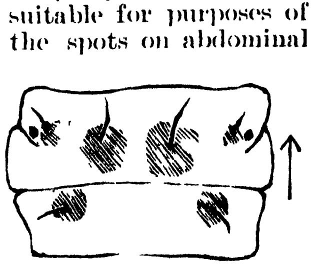
Full-grown caterpillar of *Diatraa saccharalis.*

The pronotum forms a hard shield, dark brown or black in colour; the remainder of the body is soft, with regularly arranged short hairs set in the circular brown spots. The stigmata are black and occur apparently on thoracic segment 1 and on abdominal segments 1 to 8, that on the prothorax and on abdominal segment 8 being the largest, the latter being dorsolateral, not lateral, in position. The ventral surface is uniformly dirty white, without the brown spots that occur on the lateral and dorsal surfaces. The spots and hairs are thus arranged in abdominal segments 1 to 7: on each side, one anterior dorsal spot, one posterior dorsal spot, each with a single hair: one dorso-lateral spot, with a single hair, lying dorsal and slightly anterior to the spiracle: one lateral spot, with two hairs, placed ventral to the spiracle, and a latero-ventral spot with one hair, slightly posterior to the lateral spot. The last is often faintly marked. No well marked ventral spots occur, though short hairs can be found.



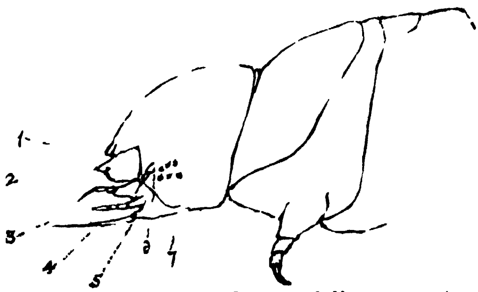
Lateral view of the first abdominal segment of the full grown caterpillar.

The spots on the thoracic segments and on abdominal segment 8 are often confluent, and differ slightly in their relative positions. The description given by L. O. Howard in "*Insect Life*," (38) agrees with this but is slightly more complete. The most constant character that is suitable for purposes of identification is the arrangement of the spots on abdominal segments 1 to 7, as the relative sizes and position of those on the thorax and posterior end of the body are variable. The mouth parts consist of the small labrum with a number of short hairs, large toothed mandibles, comparatively inconspicuous 1st maxillæ, and an under lip with the slender median hypopharynx. This functions as the spinneret, as in other Lepidopterous larvæ. The thread is double, the two filaments separate,



Dorsal view of the first abdominal segment of the full-grown caterpillar.

and is capable of supporting the weight of the full grown caterpillar. This thread is used for closing up the hole the caterpillar makes, and the newly hatched caterpillars hang by the thread from the edge of the leaf. It may also be of use to the caterpillar in climbing the stems of canes. If a caterpillar is placed on a slippery surface, it makes a foothold for itself with this sticky thread as it walks.



Lateral view of the head of the full grown caterpillar. 1. The labrum 2. The mandible. 3. The maxillary palp. 4. The hypopharynx. 5. The labium 6 The antenna. 7. The ocelli.

When fully mature the caterpillar makes a large hole to the outside, spins threads across it, retires a little way inside and sheds its last larval skin.

4. THE PUPA.

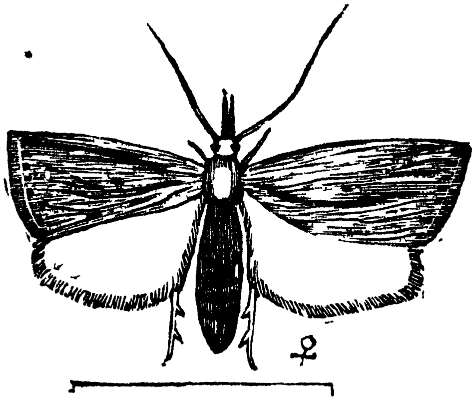
The pupa is naked, shining brown in colour, with short spines and callosities on the abdominal segments. The pupæ vary in length from ½ to ¾ of an inch and are capable of making violent movements with the abdomen. Their position in the gallery is with the head towards the opening, thus the moth is not impeded by the pupal skin when it emerges. The period of pupation is 6 days

The pupa of *Diatraa saccharalis*.

5. THE IMAGO.

The adults are by day inactive, remaining motionless under shelter. At night-fall they become active and may be caught in the canefields some time after sunset. Neither the male nor the female appear to be strong fliers and all those that were kept in captivity died after the second night if the sexes had united; if kept isolated, they will not live beyond the 5th night One female lays from 100 to 300 eggs. in captivity: I consider from 150 to 200 the usual number. Turton (3) gives the following translation of Fabricius' (2) description: "Wings striate cinereous, the hind margin dotted with black; body small, cinereous, immaculate: upper wings sometimes immaculate: lower wings white immaculate."

Gosse (6) says "A small sized straw coloured moth, with upper wings of a tint best described as ochry drab, varied with darkened

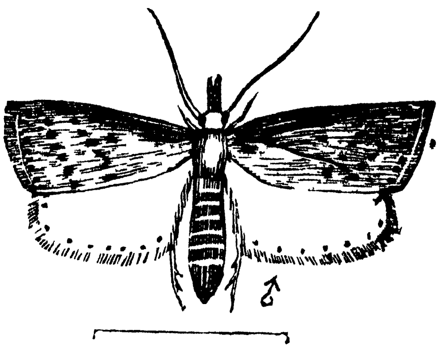


Adult female of *Diatraa saccharalis*

lines and margined dots. The under wings are pale yellow."

Cockerell (15) supposes the first of these to refer to the male, the second to the female; clearly, this is a slip, as the description by Fabricius applies to the female, that by Gosse to the male.

H. A. Morgan (80), quotes the following description from Fernald's Crambidae of N. America: "Expanse of wings 28-38 mm. Head palpi, ochre yellow, the latter with darker venular and intervenular lines; one discal and seven terminal dots, black. Hind wings white in the female, pale yellow in the male. All the fringes concolorous with the adjacent parts of the wings. There is a curved line of more or less distinct brown dots from within the apex across the wing, curving in towards the base of the hind margin, and also a trace of a second parallel line between this and the end of the cell. These lines occur more or less distinctly in the males and also in a few females." The last description agrees with the characters shown by the moths caught in Barbados, with one minor distinction. The hind wings of the males are coloured similarly to those of the females, that is, a silvery white. In some males there is a number of faint black spots at the hind edge of the lower wings. The proportion of males to females seems to be about 45 males to 55 females. It is not easy to distinguish the sexes; the variation in size is considerable, some females being smaller than the larger males: the colouration of the wings is not uniform in either sex, the brown spots of the wing being present in a majority of males, and a few females. The males may be said to be as a rule smaller than the females, with darker forewings; but these two characters will not suffice for separating the sexes. The feature that is best employed is the external genital orifice. In the female, this is terminal, and the united lobes of the ovipositor may be seen, forming a brown, oval stump, densely covered with hairs. In the male the genital orifice is slightly anterior to the hind end of the body, being better described as ventral than terminal: the pointed styles and complicated genital apparatus may be seen with the help of a good lens.



Adult male of *Diatraea saccharalis*

In "*Insect Life*," (38) C. V. Riley and L. O. Howard discuss the question of the identity of the moth borers. Professor Riley came to the conclusion, from an examination of a number of moths, that the specimens reared from corn and cane belonged all to one species. There is a considerable amount of variation in the colouration of the larvae, in the size of the pupae, and in the size and colouration of the adults. Yet it is impossible to separate them into two or more groups as these variations blend so gradually into one another.

The larvæ vary in colour, chiefly on account of the depth of colour of the spots, and the amount of fatbody present under the skin. The pupæ vary greatly in size, between certain limits, as do the adults. Each sex varies in size and colour, some females being smaller or darker than the largest or lightest coloured males. The actual markings on the forewings are not constant; the 7 black spots at the hind margin are always present and the discal black spot is almost universal, though it may be very faint. It is impossible to separate these into two or more groups, whether they are reared from cane or Indian corn, and we must conclude they are all one species.

6. PARASITES.

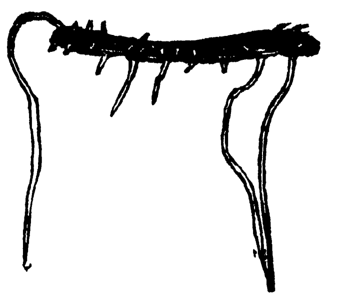
There are two parasites of the moth borer known in the West Indies as commonly occurring: *Trichogramma pretiosa*, a chalcidid Hymenopteron, which attacks the eggs and *Cordyceps* (Isaria) *Barberi* which attacks the larva or pupa.

In Barbados a proportion of the eggs of *Diatræa saccharalis* are found to be black and not the normal colour. If these are kept, in a short time a number of minute flying insects emerge. Through the kindness of Dr L. O. Howard, this has been identified as *Trichogramma pretiosa*, Riley.

Female of *Trichogramma pretiosa*
Magnified 39 times

The life history if worked out in detail would undoubtedly be of great interest. If eggs of moth borer are shut up with some of these parasites, they will within 36 hours commence to change in colour, deepening slowly to black. If they are then dissected, immature pupæ are found in each egg: that is, the parasite has reached a stage when the imaginal appendages are commencing to form and are visible on the exterior. This is the youngest stage that I have been able to find by simple dissection. Elaborate methods of section cutting are needed to elucidate the life history, which is of great interest in insects of this group. The pupa is soon fully formed, two or three being found in each egg and the metamorphosis is passed through in 6 days or less. The mature insect makes a neat round hole and leaves the empty, black eggshell. This parasite receives further treatment under remedies. A similar parasite, belonging to the same genus and possibly the same species, is recorded by Barber (60) from St. Kitts, and Dr. L. Zehntner (75.76) states that the eggs of *Diatræa striatalis* in Java turn black in consequence of the attack of *Chaetostricha nana*, a similar parasite.

Cordyceps (Isaria) *Barberi* is recorded from Antigua, St



Larva of *Diatræa saccharalis* killed by *Cordyceps Barberi.*

Kitts and Barbados. Descriptions of this fungus may be found in the writings of *Giard* (70) and *Massee* (74). Larvæ attacked by it become hard and "mummified."

"When fully developed the sclerotium has completely destroyed and replaced the internal structure of the larva, on which it is parasitic, the skin alone remaining intact." (*Massee*)

"This species is noticeable for the fact that the ascigerous portion *(appareil fructifère)* emerges from the mummified insect not only at the spot usually chosen . . . . that is the neck, but rather on the forehead between the chitinised plates of the head, and very frequently symmetrically from each segment as well, either at the origin of the legs or near the stigmata." (*Giard*).

"The larvae are attacked by the fungus while lying in their burrows in the cane stems. The fungus springs from every part of the caterpillar, hence the (ascigerous) stems vary in length, those originating farthest away from the burrow being longest, as all the stems appear to grow towards the opening and push the ascigerous portion into the air." (*Massee*).

Few specimens of attacked larvæ occur in Barbados, though they may be found in the mature canes. The Hon'ble Francis Watts in a letter dated April 10th 1900, says of *Cordyceps Barberi* in Antigua: "It is fairly abundant and a useful ally." Attempts have been made to disseminate the fungus artificially and employ it as a direct remedy against *Diatræa saccharalis*, but hitherto these efforts have not proved entirely successful.

7. INJURY.

The cane is never free from the attack of the larva of *Diatræa saccharalis*. As soon as the young leaves are up, the moth borer commences its attack and dead hearts, early in the year, are the results. Sometimes the whole plant is killed, and a fresh piece of cane is put in the hole. In the majority of cases one or more shoots die and other shoots grow up. Until the cane is so far advanced as to form joints, the attack invariably results in a dead heart, which is often cut out; in this case, fresh shoots spring up, and it is probable that no direct harm is done in these cases, and in a few cases good may be done by the encouragement of a greater number of canes per hole. When the cane forms joints, the caterpillar eats tunnels in the joints, destroying a certain quantity of the tissue of the cane. A large number of caterpillars must affect one cane, in order to seriously damage the cane and the sugar content *by their work alone.* It is true that the caterpillars are very abundant, and I have frequently had difficulty in finding a cane unattacked by borer, and sometimes have not been able to do so, but the actual damage directly caused by the borer is not the only trouble. Why the moth borer is a pest of

such magnitude is that, without it, the *rind fungus would not be able to cause the very great amount of destruction it is now doing.* Canes attacked by fungus are worthless, the sugar is gone, the cane smells sour, and the juice is not only valueless, but directly harmful to the juice of good canes. The loss of sugar in Barbados is due, primarily to rind fungus (*Trichospheria sacchari*) but only indirectly to moth borer, which opens a way for the fungus. This point has been well brought out by several writers: "I believe that fully 90 per cent. of the canes attacked by rind fungus had already been attacked by the moth borer; but I may add that I have seen the rind fungus on some canes that had not been attacked by the borer." (*J. R. Borell*, 89). C. A. Barber (60) says: "The fungus is our greatest enemy and the moth borer is its greatest ally; the fungus rots the cane and the caterpillar of the moth borer opens the door to it."

The Commission appointed in Barbados to investigate the moth borer and other cane diseases reported as follows: "In any crop up to the month of December, it would appear that the number of canes attacked by Rind fungus alone is small. It would seem that in Barbados up to December in each year the fungus makes an entrance into the cane at spots injured by the moth borer, which must therefore be looked upon as a very serious insect pest." (62).

These statements show clearly that moth borer assumes the rank of a serious pest more on account of the rind fungus, than on its own merits. Those who have seen the rind fungus, will know how destructive it is: the Barbados Commission (62) summed up the situation thus:

"The result of this disease (*Trichospharia*) is, that canes, which if they had remained healthy would have given a large yield of rich juice, are found to be absolutely valueless, and so far from themselves yielding sugar, their presence among crushed canes actually leads to a marked deterioration of the juice and the sugar manufactured therefrom, as well as to a diminution in the quantity of the sugar obtained. This disease is present in probably every canefield in the island, and the total crop of 1894 is clearly found to be very seriously diminished by it and your Commission has formed, after the most careful consideration, the very disquieting opinion that if it be left unchecked, the cultivation of the sugar cane will be rendered unprofitable and therefore extinct in this island."

Those who have seen a Barbados canefield will know that rind fungus and moth borer are very prevalent, and the heap of rotten canes that accumulates daily during crop season testifies to the destruction caused by the rind fungus, and its ally the moth borer.

So far as can be seen, in Barbados all varieties of canes are attacked by moth borer caterpillars. Some are said to suffer less, and this may be a question of a narrow leaf when the cane is young. Certainly, the adult alone can choose which cane to infect, as the caterpillar could not walk very far in search of another variety of cane. The hardest, as also the softest are in Barbados all bored by *Diatræa saccharalis.*

The moth borer of the West Indies and America is known to live on other plants than cane: this increases the difficulty of ever eradicating the pest, in localities where either of these food-plants grow in a wild state. L. O. Howard (38), records that in the United States. Indian corn *(Zea Mays)*, *Sorghum vulgare* and Gama grass (*Tripsacum dactyloides*), are eaten by *Diatraea saccharalis*. H. A. Morgan (80) adds Johnson grass (*Sorghum halepense*) to the list. In Barbados I have seen Indian corn and Sorghum attacked by moth borer caterpillars and they appear to be identical with the sugar cane borer.

8. REMEDIES.

A considerable number of recommendations may be found in the literature of cane diseases, adapted to the different circumstances for which they have been framed. It will be of interest to consider some of these and discuss their suitability to conditions such as obtain in the West Indies. Guilding (4) mentions that the remedy found to be successful in St. Vincent was trashing *i.e.* pulling the withered leaves off the old canes, in order to deprive the young caterpillars of shelter. Gosse (6) states that he was informed of the same remedy by a Jamaican planter, who found it efficacious. This simple recommendation occurs in the writings of later observers, and would appear to have been found a suitable remedy. I have been unable to discover in what way such a practice would affect the moth borer. As already stated, the eggs are laid on the green leaves, and the young larvae shelter in their axils or under the leaf sheaths. No opportunity has presented itself of testing the remedy. H. Ling Roth (22) condemns the practice in his writings from Queensland in 1885, and the value of the remedy appears to be questionable, as far as it affects the spread of the moth borer.

Porter (5) writing in 1830, recommends a pinch of lime in the heart of each young cane. This to be efficacious must be renewed periodically, and would doubtless destroy many young caterpillars if it could be done say as often as once a fortnight. But better results can in my opinion be attained by more economical methods, involving less labour. J. O. Westwood (10) in 1856, recommended that all trash, rotten canes and other refuse be allowed to accumulate on the field and then burnt. This remedy has also found favour with other writers, and would be efficacious and cheap where the conditions permit of its being performed. In Barbados, this remedy does not seem to be applicable, the loss of organic matter caused by it is too great when the tropical conditions and small depth of soil are taken into account, and in such a densely cultivated island, the fire would be very difficult to keep under control. This practice obtains in St. Kitts, and the following quotation from a letter from a planter in St. Kitts testifies to its value: "In 1894, there was a considerable amount of damage done to my canes by the borer. I used one remedy, viz., burning the field as soon as the canes were reaped, starting on the lee side, the fire moved very slowly-- being against the wind, -after it was over there was not a living insect to be seen. I think this is a more effectual way than picking up the diseased canes and then burn-

ing them, thus only destroying the many and leaving the few, which doubtless rapidly multiply. Since doing the above, I have been practically without the 'borer' in the shape of a 'pest.' " *(Jas. Douglas Adamson.)*

On the other hand, H. A. Morgan (56) in the report of the Louisiana Experiment Station remarks: "Planters have very generally burnt the trash and yet the attack has apparently not been lessened."

Another remedy was proposed by W. E. Gill (16) in Demerara in 1879. He considered that the supply of silica in the soil was used up by continual cultivation of sugar cane, and that the prevalence of insects was due to the lack of hardness in the rind of the cane produced by the absence of silica. He advised placing sand round each hole. Unfortunately no reference can be found to any trial of this remedy.

In 1879, the Royal Agricultural Society (15) issued a circular in Demerara, to elicit information and make recommendations. They advocated burning the trash, crushing the rotten canes, soaking plant canes in water heated to 125 F., encouraging birds and other enemies of the moth borer, and also cutting out the diseased canes. About the same time Miss Ormerod took up the question of cane pests, and recommended that the diseased shoots should be cut out and destroyed, whilst lime and mould be placed on the cut stump. She also suggested that the plant canes be soaked in some solution that would destroy any caterpillars that were in or on them.

The practice of cutting out diseased canes is of the greatest value in directly combating the moth borer, and is carried out in Barbados at the present time. Writers from different parts of the world have found this a suitable remedy, and so far as can be judged from the available literature, it has been adopted in Queensland (23), Teneriffe (63.88), the West Indies (59, 62, 89, etc.) and other localities with marked success. *Cutting out should commence a few weeks after the cane is up, that is, as soon as a dead heart can be seen.* The withered shoots are cut out very low down, to ensure the destruction of the chrysalis or caterpillar inside, and are brought away from the canefields. They may be disposed of, as circumstances permit, in any way that will destroy the borer. If no use is found for them they may be immediately burnt: otherwise they may be fed to stock, chaffed up, or put on the compost heap and well covered over. The essential thing is to destroy the borer, and make sure of lessening the number as much as possible Where fodder is scarce, and it is desired to keep the dead shoots for a short time, each should be split up and the caterpillar or chrysalis destroyed. Where a silo is being made up, they may be put in without any risk of escape of the caterpillar or moth.

Steeping plant canes in either hot water or some preservative solution has also been widely adopted to judge from the frequency with which it is mentioned. Its bearing on the destruction of the pest is in my opinion slight. Any young caterpillars on the plant cane would be destroyed, but the actual planting would in all probability effect this, provided

the cane had first been stripped of all dry leaves. A hot liquid would destroy the caterpillar if the cane were sufficiently long in the hot liquid to become heated throughout. Mr. J. R. Bovell's experience is that the liquid does not as a rule penetrate the tunnel of the caterpillar, as might be expected from the small size of the tunnel itself. This remedy may have a greater effect in destroying the Rind fungus (*Trichosphæria*) but does not appear to be sufficiently effective with the moth borer.

Professor Comstock (17) advocates remedies that are inapplicable to the conditions of a tropical country, where growth is continuous and there is no winter. Such is the practice of burning the stubble, a recommendation of the greatest value in Louisiana, where the larvæ hibernate in the stumps of the cut canes. He also draws attention to the need of careful selection of plant canes. This is a matter that cannot be too strongly borne in mind, and were it not that even at the present day the most diseased canes are occasionally selected as plant canes, such a recommendation might have been considered superfluous.

Professor Riley and Dr. Howard (36) suggested spraying with Paris green, in a special case where immunity was desired from the attacks of moth borer in an experimental field. The costliness of such a remedy would prevent its adoption on a large scale as part of the practice of a sugar estate.

In the West Indies the subject of remedies received especial attention from 1892 onwards. The subject was taken up in St. Vincent by a committee of planters (61), in Antigua by the Agricultural Society (65) and in Barbados by the Commission appointed for the purpose of investigating the moth borer and other pests (62). In addition there are the writings of G. W. Smith (17), C. A. Barber (57, 59, 60, 61, 77.), J. P. d'Albuquerque (50), and J. R. Bovell (89), containing recommendations based on the especial needs and conditions of the West Indies. It will be convenient to discuss these recommendations without reference to the authors or the chronological sequence :—

1. *The plant canes are to be carefully selected.* This is less of a remedy than a plain piece of common sense practice.

2. *All dried and decayed canes are to be burnt as soon as possible after the cane has been cut.* This recommendation is efficient, practical and inexpensive, and should form part of the usual routine of estate work. Frequently, when the ripe canes are cut and taken to the mill, the dried up diseased canes are left on the field with the trash. These are infested with rind fungus, moth borer and other pests and constitute a serious source of danger, by serving to assist the spread of these diseases. They should be removed as soon as possible, the juicy ones ground in the mill, apart from the sound canes, and the whole heap burned as soon as possible. They would not then serve as nurseries of disease. This is the gist of the recommendation and had it been carried out since it was so strongly urged on sugar planters, there would now be far less disease. In Barbados at the present time these canes are

very generally destroyed at the end of each week but it is no uncommon thing to find that they are either left on the field, or are brought in and left in the yard, to be ground and burnt at the end of the crop season or whenever convenient. In the pressure of crop season, it is not possible to grind these as often as would be desirable, but every opportunity should be taken to destroy them. The juice must not be allowed to mix with the juice of the sound canes.

3. Cut out diseased canes. This is possible in the early period of the cane's growth, and its great usefulness as a direct measure against the moth borer has already been discussed.

4. Soak the plant canes in solution before planting. Such liquids as lime water, Jeyes' fluid, and carbolic acid are recommended, the plant canes to be soaked for 12 to 18 hours. An alternative is to use water heated to 130 F. This latter remedy, as already stated, has little bearing on the question of moth borer. It was originally recommended for the rind fungus.

5. Encourage enemies. Cordyceps Barberi and *Trichogramma* are the two enemies already mentioned: attempts to spread *Cordyceps* have been unsuccessful so far and no feasible way suggests itself of assisting *Trichogramma* in its work of destruction. As the moth flies at night, and lies hidden by day, birds will probably do little against moth borer, but bats may be of service in this respect.

6. Destroy the stumps of canes, that are not to be ratooned, as soon as possible. As soon after reaping as convenient, the stools were to be dug up, and burnt or otherwise destroyed. This was based on the habits of the moth in the United States, where the caterpillar hibernates in the stumps of the cut canes. This does not appear to take place under tropical conditions where there is a constant supply of growing canes.

7. Burn all ratoon pieces within 14 days. This recommendation, like the last, would have little effect on the moth borer. In places where the trash can be fired as well and there is no danger of the spread of the fire, this practice has given excellent results, as shown at St. Kitts.

8. Do not ratoon. This was recommended for Barbados, where the burning of fields cannot safely be undertaken.

9. Cover ratoon stumps with lime. This would be a good remedy were there any caterpillars in the stumps. Its effect on moth borer would not seem to be very great.

10. Place half a pint of lime in each hole. I am unable to see how this could affect the moth borer. The larvae are inside the canes, and would scarcely be affected by the lime, which would need to be continually renewed.

11. The trash from the old canes is not to be spread round the young growing plants. This question requires thorough investigation, before it can be profitably discussed. If the eggs or caterpillars of the moth-borer are carried thus to the young canes, the practice is dangerous in the extreme. But there is no evidence that this is so and the advantages derived from the practice under tropical conditions are too great to allow of hasty condemnation. A matter of this kind can be investi-

gated only on a large scale, and planters should best be able to decide the question.

12. Introduce rotation, planting a non-gramineous crop in alternation with sugar cane. This would be serviceable if a large block of land could be kept under some other crop for a whole season; but as long as young canes are planted between the mature canes or near them, the moths will spread.

13. The last recommendation is that of using lights to catch the moths. This practice originated in the United States, and has been recommended in Barbados and elsewhere. It has been practiced with considerable success in Barbados and St Kitts. A lighted lantern is suspended over a pan of molasses and water, or kerosene oil and water; the moths are attracted by the light and fall into the liquid. Any light that is sufficiently powerful and will not blow out is suitable, and the most favourable position for the lights is to leeward of the patches of old canes. On an estate in Barbados, 6,700 moths were caught at 6 lights during the months from June to December of one year. I am able to quote a letter from a planter in St. Kitts, who describes the arrangement he uses:

"A shallow wooden tray about 1ft. 6ins. square, 2ins. deep is nailed on a rough post at a height of 2ft. 6ins. from the ground the tray being pitched (to prevent leakage) has a covering of about half an inch of molasses and water in the middle of which is the lamp, a tin cup 4ins. high by 2ins. in diameter with a moveable top, any old rag serving as a wick, the shade being a whisky bottle, with the bottom taken out. The tin flange of the lamp is nailed to a block of wood, which is also nailed to the bottom of the tray, the bottle shade resting on three pieces of wood ¼ of an inch thick to allow of sufficient air to permit proper combustion. To get the bottom of the bottle taken out is easily done by filling it tightly with fine sand and tapping all round with a convenient piece of iron. The lamps are placed in fields of cane etc., 24 being used. Place the post firmly in the ground to prevent dogs upsetting it for the molasses." *(J. D. Adamson).*

The majority of the remedies discussed appear to ignore the moth borer to too great an extent. The cultivation of any crop involves a fight with pests of some description, but modifications of the routine of estate work will not destroy the pest itself. Direct measures against the pest are likely to prove successful, combined with preventive measures and judicious cultivation. Knowing the life history of the pest and its habits, the most easily assailable points may be selected and direct means taken to secure its destruction by taking advantage of its weakest points. Complete reliance cannot be placed on preventive measures; vigorous measures to directly secure the extermination of the insect are needed and are the mainstay when a pest attains such large proportions. The most easily attacked points in the history of the moth borer are these three: 1st. The eggs, laid openly on the leaf of the cane; 2nd. The larvæ or pupæ in the deadheart; 3rd. The moths flying at night. On these three the direct methods of extermination can be based. The destruction of the larvæ and pupæ in dead hearts and the cap-

ture of the moths by means of lights have been already discussed. There is another remedy that is deserving of careful attention. It has been already stated that Indian corn (*Zea Mays*) is one of the plants attacked by moth borer. It has been used as a trap crop by cane cultivators in the Canary Islands. I can find but one reference to it, which I will quote: "Here, (Teneriffe) the borer is also said to prefer maize to cane, and when cane was grown by small farmers, they were in the habit of sowing a few grains of maize in spots of cane that were known to be frequented year after year. and when these got full of borer, cutting them out. There is no doubt that it is extremely fond of maize and I have taken as many as 37 in one stalk." (*D. McPhail*, 88.) This refers to another borer, probably *Sesamia* but the same habit is found in *Diatræa saccharalis*. Indian corn is attacked by the moth borer, and from a case that came under my notice I consider it prefers maize to sugar cane. Maize was growing between the young canes, and whilst the canes were free from attack, the maize was eaten up with moth borer, and other caterpillars. Mr. McPhail's suggestion is a very sound one, and it would seem to be a simple matter to sow corn between or near the young canes, and destroy the borers, before they were able to complete their life history. It would be necessary to cut out the maize within 6 weeks of the first attack, and if the plants were only slightly affected, they might be fed to stock, chaffed up or put in the silo. If they were badly attacked, as would probably be the case, the whole might be burnt with some dry trash, or buried deep in the compost heap.

There is one more remedy of importance left undiscussed, and that is collecting the eggs. In a recent pamphlet "Moth Borer in Sugar Cane," I advocated this remedy and I was not then aware of the fact that it had already been suggested by two writers. Dr. L. Zehntner (75. 76) recommended it against the moth borers of Java and this is the earliest reference I have been able to find to this remedy. In the "*Sugar Cane*" of Dec. 1899, a letter from Mr. D. McPhail appeared, which I have already quoted and he alludes to this remedy: "When I mention that on one of our estates here (Teneriffe) containing about 120 acres of cane, nearly 15,000 deposits of eggs were found and destroyed during the months of June and July, . . . the importance of doing this will be recognised." This refers to an allied borer, as does Dr. L. Zehntner's recommendation. I take this opportunity of expressing my regret that in the pamphlet recently published, no mention is made of the earlier recommendations of Dr. Zehntner and Mr. McPhail.

The collection of the eggs has been carried out to a small extent in Barbados, during April and May. I am in a position to give some details of the work. First, as to the number of eggs laid. In my own collecting in February and March, I found an average number of 70 egg clusters per acre. It must be borne in mind that these are egg clusters which have not hatched and therefore have been laid within, at most, a week. Figures obtained from the results of the collecting by gangs of girls or boys during April and May show higher results

From various localities, the numbers were, 155 per acre (50ac.), 102 per acre (100ac.), 133 per acre (82ac.), 105 per acre (70ac.), 350 per acre (5ac.). These figures will give an idea of what abundance of eggs are laid every week on the canes. To collect eggs, it is necessary to have a gang of boys or girls, with knives and either sacks, or better, boxes or tins, in which to put the eggs. They go regularly over the estate, and I have found them very sharp-sighted. They bring in anything that has a faint resemblance to *Diatræa* eggs, and one girl or boy will do from 2,000 to 3,000 holes of young canes per day. They will of course bring in hatched eggs as well, unless told to leave them, and the proportion of these will be very large if that field is being done for the first time ; but these are best left alone, and are not counted if brought in at the end of the day.

During the early part of this year, I found such great numbers of eggs clusters and could collect them so easily, that at a meeting of the Barbados Agricultural Society in March last, I strongly urged the collection of the eggs as the simplest and most direct remedy. It should form a part of the regular routine of every estate, and cannot fail to destroy the moth borer and would in fact ultimately eradicate it, since the moth must lay eggs on the young canes during the crop season and after it. There is just one season when egg collecting is especially valuable. Up to June, there is a supply of both old and young canes for the moths to lay eggs in. But when the canes are cut, where are the moths? All in the young canes! Their eggs can be collected then and must *all* be in those young canes : so that when the crop is finished, in June, is the time to catch all, the eggs being laid on the smallest possible area, not only of land but of plant surface. The following diagram illustrates the distribution of the moth borer eggs during the year and

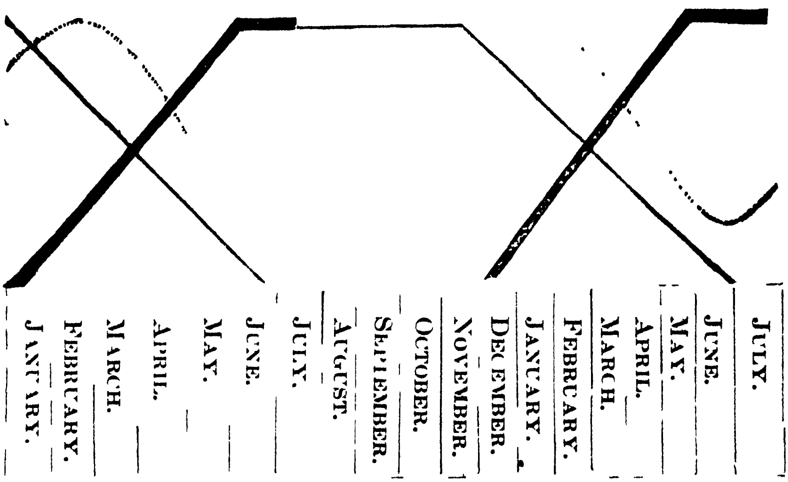


Diagram shewing distribution of moth borer.

The thickened line rising over January in each case represents the relative number of moths laying eggs in the young canes. These eggs can all be collected. The thickened lines it will be noticed end over July. The thin line in continuation represents the relative number of moths laying eggs in the

shows also that the amount of leaf surface is at its minimum in June and July, so that then is the best possible time for ensuring the death of the moth borer. If it were possible by turning all hands on at this season, to examine every cane, once a week for 6 weeks, there could be but a very small number of moth borers left alive.

9. PARASITISED EGGS.

There can be no doubt as to the value of egg collecting as a direct remedy, and some planters in Barbados took it up in April and May. The eggs then collected were however found to be composed of a large proportion of black eggs. This was opposed to my experience in the earlier months, but the results of the collecting show that during April and May a great increase took place in the numbers of the parasite, till in May as many as 75 per cent. of the eggs were destroyed, and in some cases a higher percentage. It was felt that more harm was being done than good, and it was recommended that the black eggs should be left on the plants, all others being collected. This was a provisional recommendation till the subject could be investigated afresh, with the benefit of the experience of April and May. It has been clearly seen now that it is not a safe practice to leave the black eggs on the plants. Careful examination of a great number of eggs has shown that it is not possible to distinguish fully mature normal eggs from recently parasitised "black eggs," without a good magnifying glass. The gangs, if told to leave black eggs, will certainly leave a proportion of the fully mature normal eggs on the plants under the impression they are black eggs.

Another reason is that a proportion of the parasitised egg clusters are not entirely parasitised; some give rise to caterpillars. This is natural, as the *Trichogramma* must have some limit to her capacity for laying eggs, and has not sufficient for the whole cluster in some cases. To fully satisfy myself on this point I examined many thousands of egg clusters as they were brought in from the fields by the gangs, or as soon after as possible, and of the black egg clusters 19·5 per cent. had a proportion of sound eggs. It might be but one normal egg to the cluster but that hatched to a caterpillar. For these two reasons it is impracticable to send a gang out to collect all but the black eggs. They will leave about one-fifth with normal eggs, besides a proportion of the fully mature normal eggs.

The problem then resolves into whether to leave all the eggs alone, and do no work against the moth borer or to collect all the eggs and destroy the parasite as well as the eggs. I will give my reasons below against putting any trust in the parasite and will now state my conviction that it is useless and dangerous to trust in any degree to the parasites. Equally it is harmful to destroy so many parasites. Fortunately there is an alternative that secures the destruction of *all* the normal

canes too far advanced for egg collecting. The dotted line represents the relative area of leaf surface throughout the year. It will be seen that the period of minimum leaf surface coincides with the time when all the moths are laying eggs in the young canes, and when they can all be collected.

eggs and does not destroy the majority of the parasites in the black eggs.

It has been found, that if all the eggs alike are collected, and kept in the open air where they dry up, that the majority of the caterpillars die before they hatch; but also that all the parasites that have reached the early pupa stage are not affected and will hatch out as usual. Parasitised eggs were kept in a calcium chloride dessicator. One egg was dissected beforehand and contained immature pupae just forming; these eggs hatched to the usual active *Trichogramma*, which appeared in no way affected by the excessive dryness. The feasible recommendation then is to collect the eggs, *all* but those that have hatched; to place them in the yard on any spot remote from the canes for a few days, till all the *Trichogramma* escape. Any caterpillars that hatch may then be destroyed with boiling water or the whole lot burnt. I would suggest that the eggs collected on Monday, Tuesday and Wednesday, be all put, as they are collected, in one spot and left till the following Monday; and that all the eggs collected on Thursday, Friday and Saturday, be put in another spot and kept till the following Thursday. Thus, all confusion will be avoided and all the eggs get their due amount of time.

It may be said that where 75 per cent. are being destroyed by parasites, it is not worth while collecting. Yet it is still necessary to collect the eggs even where as many as 75 per cent. have been attacked by the parasites. Taking as an estimate 100 clusters of eggs per acre per week, 75 per cent. are destroyed, leaving 25 to hatch; that gives 475 caterpillars *per acre per week* 475 caterpillars per week now, when the parasite has the best possible chance of doing her work, are quite enough to do a considerable amount of damage, and it would rise to many more per week, when the parasite is not able to destroy 75 per cent.

It will in my opinion pay to collect eggs, so long as it pays to take any measures against moth borer at all. This remedy is the most direct, the simplest, and will compare very favourably with every other where labour is cheap. It needs men or women to cut out dead hearts or to put up lights, or to carry out any of the remedies that affect the routine of the estate; but this work of egg collecting is best done by the sharp eyes of girls or boys, and in consequence costs less.

10. RELATION OF TRICHOGRAMMA TO DIATRÆA.

There is one other aspect of the question that needs to be discussed and that is, what part the *Trichogramma* is playing. Will it ever get rid of the moth borer? I think not, and I wish to guard against a false sense of security brought on by the idea that the parasite alone will sufficiently destroy the moth borer. It is stated above that during the earlier months of the year little trace of the work of the parasite could be found and that it increased during April, reaching large proportions in May. Though I can find no reference to the length of time it has been in Barbados, I think there is reason to believe it has been in the island for some years. I wish to offer a hypothetical

explanation of the small number of the parasites in the early months and its great increase during April and May.

From the end of July 1899 to January 1900, the only sugar cane in the island was that to be reaped this season, *i. e.* cane that was getting tall, too tall to cut out dead hearts or to collect eggs in. All the *Trichogrammæ* then were living in the eggs laid on this cane. In January the young canes planted in December came up, and from January to June of 1900 there was a large area of young cane ; as the months of 1900 went by, an increasing amount of the old cane was reaped, and the moths went more and more to the young canes to lay their eggs. What is the effect on our parasite ? It has considerably less difficulty in finding the moth borer eggs on the small canes, especially when so many moths must come and lay eggs on these small plants. It can in consequence multiply at an enormous rate in the months of March, April, May, June ; but afterwards the cane gets tall, the number of canes to each stool increases, the whole field becomes a tangled mass of canes 5 to 8 feet high, each with a large crown of broader leaves, and the result is that the *Trichogramma* has an increasingly greater difficulty in finding the eggs of the moth borer. Thus during the later months of the year the numbers of the parasite diminish and more borers escape to eat the canes.

Nothing but a few years' experience can settle the question but I consider the above hypothesis is worthy of consideration and that this will be found to be the normal sequence of events.

The relations of the *Trichogramma* to the eggs of the moth borer are of interest to sugar planters from a practical point of view, and it may be of interest to discuss the question from a more generalised stand point. Is the parasite going to appreciably affect the total number of moth borers in Barbados ? Will there be as many in the crop of 1901 as in that of 1900 ? These are questions that need an answer and I am inclined to consider that the parasite will leave us every year with the same number of borers, and the same amount of damage to the cane. The parasite, may, in my opinion, be left out of consideration altogether from a practical point of view so long as we avoid destroying it.

The number of moth borer eggs laid on the plants is so large, that were all to hatch and come to maturity, there would be no cane to grind in 6 months' time. The figures given above vary from 70 to 350 egg clusters per acre : take 100 clusters as a reasonable average : that is 1,900 caterpillars hatch, *per week, per acre*. Allowing one-half only of these to come to maturity, there would be 950 moths flying in 6 weeks. Of these about 500 would be females, and they would lay 50,000 eggs as a minimum, *per week, per acre*. This process is continually going on and if the calculation is carried on to 6 months, there would then, on the basis of half the caterpillars dying, and each female only laying 100 eggs, be at least 900,000,000 (nine hundred millions) of eggs laid, *per week, per acre*. Long before this there would be no room in the island

for anything but caterpillars. These figures are given only to show that there must be some very active check working to lessen the numbers of the pest. Nature very rarely works in this way, letting an insect disturb the balance of life by sudden increase, and the relative balance is as a rule kept level. There is a very effective check on the moth borer and it seems reasonable to put the *Trichogramma* down as part of this check. Will the *Trichogramma* ever be anything beyond a check? No, for that is not Nature's way. There is in nature a continual struggle, and the result of the struggle is that one organism never oversteps the limits, but that all are kept in their places. The moth borer could under certain circumstances increase very rapidly and were it not for the fact that it has various influences affecting it, and acting as a check on increase beyond a certain point, it would doubtless increase. If the *Trichogramma* could find and destroy all the eggs, it would itself die for lack of food, unless it was able to adapt itself to other circumstances. But these things do not, so far as we can see, occur in nature.

Admitting that there must be some influence to keep the numbers of the moth borer within limits, and admitting also that the conditions in April, May and June are especially favourable to the *Trichogramma*, the facts are accounted for by the assumption that the *Trichogramma* is *a check and no more.* The history of economic entomology abounds in instances similar to this where a pest and its parasite exist together and the result is to keep the numbers of the pest to certain limits. What we call the balance of nature does not admit of one species wiping out another in the majority of cases. If the parasite eats up the majority of the eggs to such an extent as to really diminish the number by a considerable amount, there will soon be fewer left to prey on: the parasite will then be suffering from want of food, and dies off in consequence. The pest then is less seriously attacked and contrives to pick up and should there be some favouring circumstance, as for instance the greater area on which to lay eggs and the increased difficulty the parasite has in finding the eggs, then the pest itself gets ahead of the parasite and multiplies to above the old number. But now with abundance of food, the parasite picks up and in turn decreases the numbers of the pest. We can dimly see the fluctuating relations of host and parasite, but the aggregate effect is the same over a sufficiently long period. In support of this, I will mention the island of St. Kitts. C. A. Barber (60) in 1894 stated "I have evidence that the vast majority of moth borer eggs are destroyed by a small parasitic fly." He mentions a few particulars which show that it is similar to or possibly the same as the Barbados parasite. Yet now in 1900, the moth borer is so destructive in St. Kitts that active measures are taken against it. This is a case where the aggregate effect is to keep the pest within certain limits, but not to destroy it. Every year, the same number of moth borers will escape, and this seems to have occurred at St. Kitts for 6 years, and I believe also for some years in Barbados. An eminent American entomologist, John B. Smith, read a paper on the subject of parasites at the Association of

Economic Entomologists in 1893, and I quote as follows :—

"We are right in calling the attention of the farmer to the fact that the injurious species are very largely kept in check by either parasites or by predaceous insects; but we are wrong in leading him to suppose that either parasites or predaceous insects will control the species for him. . . . . . Parasites do not exterminate their hosts in any instance, their mission is merely to interpose a check to undue increase and it is natural that this should be so, for were the host destroyed, the parasite itself would perish unless it were able to change its food and prey upon other species." Dr. Smith then gives instances where a pest has been attacked by a parasite and where the parasite has ultimately destroyed the majority of its hosts, in one case up to 75 per cent. Yet the next season the numbers of the pest are as great as they were at the commencement of the previous season. He also states that "This is not a solitary instance. It can be matched with ease in all our common insects." The conclusion he draws is that a parasite, as a rule, does no more than keep its host in check. The numbers of the moth borer have varied perhaps to some extent from year to year, but no striking alteration has taken place, either an increase or decrease. What keeps this number constant? The parasite among other of Nature's checks. Dr. Smith continues: "My contention is that in dealing with injurious insects from the farmer's standpoint, we can entirely ignore the work of parasitic or predaceous insects. We must accept the fact that each year these insects will appear in about the same numbers, that Nature has evidently assumed that this is about the proper number to appear and that all her checks are arranged accordingly. If we wish to lessen them we must do it by means other than those which she has provided. . . . . . The propositions I do make and that I am ready to defend are: Among our native insects parasites act merely as a check to excessive increase. Excessive increase means more than the natural food of the insect is able to support, and does not mean excessive increase in the sense of the farmer. An insect that is under natural conditions abundant each year must be dealt with without any regard to parasites or natural enemies. Other than I have just suggested, parasites and predaceous insects have absolutely no economic value." (John B. Smith, "*Insect Life*," 1893, vol. VI. page 142). This is the opinion of an entomologist of many years' experience in fighting insect pests. I have gone into the question at some length because I wish to guard against a false sense of security brought on by the feeling that the parasite will destroy the moth borer. When we find all the eggs destroyed by *Trichogramma* in every part of the island, we may expect no more next year. But so long as a small proportion escape when the conditions are the most favourable for the parasite, so long will the destruction caused by moth borer continue. If we wish to lessen the numbers of the pest beyond the number that naturally survive every year, we must do all in our power to aid the work of the parasite.

11. CHOICE OF REMEDIES.

With regard to the choice of remedies, the main reliance

must be placed on simple, direct measures. The best results appear likely to be attained by collecting the eggs, cutting out "dead-hearts" regularly from the time the first is seen, using lights (from July to January particularly as other remedies are not then available), rigidly rejecting and destroying plant canes that show signs of disease, and continually destroying the rotten canes during crop season, as often as the mill can be used for that purpose.

The West Indian sugar planter is to be congratulated on having as the chief source of his troubles a pest that admits of such simple and direct measures being adopted against it, and it is largely a matter of choice whether *Diatræa saccharalis* with its infinitely worse attendant evils shall be allowed to destroy his canes or not.

12. Prevention and Future Outlook.

It would be of little avail to destroy the moth borer and take no precautions against its introduction from other localities. The fact that the larva or pupa can be sent in canes used for planting should ensure rigid examination of every cane before it is sent and after it is received. If any are found with borer holes, they should be immediately burnt. The practice of sending great numbers of cane plants from one colony to the other, with no restrictions or examination is liable to neutralise the good effect that may be produced by careful destruction of the pest: and when it is borne in mind how great the number of cane diseases is, and. what havoc a newly introduced pest might accomplish in a short time when deprived of the checks it had in its former locality, it will be seen that there is a need for the greatest care in sending or receiving canes from other places.

It may perhaps be supposed that to be of any value, any action against moth borer must be unanimously taken by the whole body of planters If a planter wishes to free his estate from moth borer, he will perhaps feel that his efforts are vain so long as his neighbours are not also taking measures. Certainly, a number of moths will fly in from neighbouring fields in the course of the year, but this number will be a relatively small one, as the moth is such a weak flier. I have visited estates in Barbados where I was struck with the small number of moth borer holes in the canes brought in to be ground, and on enquiry it has proved that the practice of cutting out "deadhearts" has been carried out from the beginning of the year. This satisfied me that it would well repay a single estate to take any measure to diminish the numbers of the moth borer. Collective action on the part of the planters of a whole island or district is the sure way of diminishing the disease; combined with this there should be legislation or at least collective action to ensure the immediate destruction of all infected canes brought into that district.

The future of the moth borer depends entirely on the action taken by those interested in sugar cultivation. If planters are willing to incur the necessary expenditure, which is slight, adopting simple remedies as part of the regular estate work,

they will each benefit. But in the event of such action being universal in one colony or district, then the moth borer, and its resultant diseases, will be no more a curse to the planters of that locality, but will be preserved as a curiosity in the local museum.

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SUGAR CANE EXPERIMENTS AT BARBADOS.

The following correspondence furnishes an account of the Sugar Cane Experiments started at the close of 1898 by the Imperial Department of Agriculture in Barbados. Professor D'ALBUQUERQUE, Island Professor of Chemistry, is the Chemist in charge of the experiments and Mr. J. R. BOVELL is the Agricultural Superintendent :—

Professor d'Albuquerque—to Commissioner of Agriculture.

Government Laboratory,
29th October, 1898.

Sir,

As it is very desirable that a beginning should be made as soon as possible with the Sugar cane experiments, and in accordance with your request that a scheme should be formed without delay, I have the honour to suggest, in view of the importance of testing the relative value of Seedling canes in different parts of the island, that plots of the best known varieties of Seedling canes be established at a number of estates, each estate being typical in soil and climate of a considerable area around it a sufficient number of estates being selected to afford types, in regard to soil and climate, of all lands likely to be employed in this island for cane cultivation.

2. This mode of working will offer a much larger variety of conditions than could be obtained at any one or two "Experimental Stations," and that it is possible with advantage to utilise actual sugar estates for such experiments has been proved for some years by myself and I think also by Mr. Bovell.

3. The further advantages offered by this mode of working are

(*a*) The plots of each estate will serve as useful object lessons to the planters of the district, and being cultivated under the practical conditions existing on the estate, the results will be more convincing to the planters than if they were obtained solely at a departmentally worked station.

(*b*) The plots will serve as centres for propagating and distributing plants of those Seedlings which give the most favourable results.

4. I have only at present to add that in my opinion these variety plots should be planted at least in triplicate, and that in future experiments it may be found necessary to adopt the method of control plots to which I shall refer in detail when I submit a scheme of Manurial Experiments.

I have the honour to be, Sir,
Your most obedient servant,

J. P. D' ALBUQUERQUE,
Island Professor of Chemistry & Agrl. Science.

Dr. D. MORRIS, C.M.G., D.Sc., M.A., F.L.S.,
Commissioner of Agriculture.

Government Laboratory,
November 25th, 1898.

Sir,

I have the honour to forward the following additional suggestions upon the subject of cane experiments in Barbados.

2. So far the experiments decided upon are what may be called the practical and final testing of certain best varieties of existing seedling canes with regard to their practical value as sugar producers in different soils and climates of this island: and for this purpose it is necessary that the experiments should be conducted in one representative field of each climate and soil typical of any large area in the island. Such work as this will always be the necessary sequel to the production and selection of seedlings at central stations. At present eight local stations have been selected for this practical side, and will involve some five weeks analytical work carried out for the most part upon the estates themselves.

3. The scientific work of producing and investigating the nature of pedigreed seedlings and their relations, if any, to the parent plants and scientific questions in general relating to seedling canes, as well as the work of investigating the possibilities of improving a given variety of cane by chemical selection of plants from canes richest in sugar at the time of analysis and at different times of year, and all studies which require close chemical supervision and very numerous analyses of the highest attainable degree of scientific accuracy, will require to be done at one or two estates having suitable soil and climate with comparatively large and level fields, specially accessible from the Government Laboratory and under proprietors who themselves take a keen interest in scientific questions connected with the improvement of the sugar cane.

The extreme varieties of soil and climate typical of comparatively large areas in Barbados, are high red soils and low black ones, and between these two come every intermediate variety. I am of opinion (as far as there is any evidence) that seedlings suitable to red soils could be raised and propagated well on a black soil, and transferred after selection to the red soil: or, to put it in another way, a seedling (if such exist) which would only struggle into existence on a red soil and could not do so on a black soil would have no practical value and would be poor and weakly anywhere in the island. Consequently the actual preliminary scientific work could be done on a black soil. Again, the investigation of the possibility of raising the sugar contents of a given variety of cane by so called "Chemical selection" could be carried out on a black soil and the results would be applicable to a red one.

The total experiments (excluding analyses at planting and other intermediate times, but including the local stations) I estimate to require at least one hundred days continuous analytical work during the crop, i.e. the whole reaping period of the crop, and therefore the central stations should be near town, both for the easy accessibility to planters and visitors and for proximity to the Government Laboratory since the

analyses would then be carried out at the Laboratory. From the working point of view the advantages of this locality for the experiments are

(*a*) Saving of carriage hire (two assistants to each out station.)

(*b*) Saving of wear and tear to the workers from a long double journey each day, carrying about of food, etc. (a greater advantage than might appear at first sight.)

(*c*) The instruments being in their own home, the work is arranged solely with a view to the highest accuracy, which is not attainable in an ordinary sugar boiling house.

(*d*) I could then perform my other duties (of Island Professor of Chemistry) adequately and with ease, while the experiments are going on. This is one of the conditions agreed to in my appointment and could not be complied with if I were away from the Laboratory one hundred consecutive days.

There are no disadvantages in choice of the above locality which would not equally apply to any other locality in the island.

4. To acquire an adequate area near Bridgetown (or anywhere else) for such central station experiments three alternatives present themselves.

(1) The purchase of an estate out of Chancery (I am not aware of a suitable one near town)

(2) The leasing of part or all of an estate similar to (1)

(3) The use of land from a (near town) estate, where the proprietor supplies all cultivation and reaping labour and manures, and where the Department staff could concentrate its energies on the scientific supervision and work, and where adequate reasonable compensation is paid for experiments involving loss, which compensation could be calculated on the analyses and average yields of the other (non-experimental) parts of the estate or on these in previous similar years.

I am of opinion that a total of 25 acres of fairly level ground would be sufficient for such "loss-involving-experiments" and to secure such an area by alternatives (1) or (2) it would be necessary to purchase or lease an estate of 100 acres or more, with the carrying on of purely estate management, and the usual risk of loss on the area not required for such experiments. For it would only be the ordinary cultivated (or non-experimental) area that would not be certain to involve pecuniary loss and in proportion as the estate was more experimental in that proportion the probable loss would be greater. Under these two alternatives the estate would be semi-commercial and semi-scientific, and the Department (in the absence of a large margin of money to allow for loss) would be saddled with a responsibility outside its immediate object.

I therefore prefer alternative (3) and in furtherance of it I submit the following preliminary information:--

(1) The Pine estate, owned by J. C. Lynch Esqr., M.C.P. Barrister-at-Law, is bordered on one side by Government Hill Road, about one and a half miles from Bridgetown, and has fine large fields whose levelness and uniformity are unique in the island. I have already conducted experiments on a fair scale there and received every help that could be rendered and was left a perfectly free hand in all arrangements. The proprietor is very interested in the question of improvement of the sugar cane. He owns one other estate. He is willing to allow, say ten acres for scientific experiments involving loss, compensation being given for loss calculated on my measurements and analyses.

He intends to weigh all his canes and measure juice and control the working of his boiling house by chemical analysis: consequently it will be very simple to arrive at the loss. He is further willing to allow another (a) sufficient area, say five acres for manurial black soil plots and (b) a sufficient area for testing best selected seedlings and for experimenting in improvement by "Chemical Selection" neither of which (a and b) should involve any loss to him.

(2) Waterford estate, owned by Messrs. W. O. Collymore and F. Collymore, is situated about one and a half miles from Bridgetown. The proprietors have already conducted experiments of their own upon the estate, are keenly interested in the improvement of the sugar cane and are ready to render every possible assistance to experiments conducted on their estate.

They are willing on similar terms to allow twenty acres for scientific experiments involving loss, and any further area for experiments not involving loss. They also are about to weigh their canes, measure their juice etc., and chemically control their working: consequently, here also, it would be easy to arrive at the amount of the loss.

5. In addition to the above Central Station black soil experiments on a large scale on the nature etc. of seedling canes and on the effect of manures, and on the improvement of canes by "Chemical Selection," it is desirable to have a set of manurial plots on a red soil estate; it is also desirable to test a moderate number of seedling canes as to their general value and ratooning value in red soil at a stage antecedent to that which in the "local stations" entitles them to be called best selected seedlings. These red soil manurial and seedling experiments might be called subcentral station experiments and would serve as a stage intermediate between the black soil central station and the red soil local stations, and would enable us to obtain earlier knowledge with regard to red soils than we could from local stations. I estimate that an area of two and a half acres will suffice for the manurial red soil plots, and about five acres for early stage seedling experiments involving loss. Hopewell estate would probably be very suitable for such work.

6. It will be seen from the details appended that the estimated maximum compensation for

the year (1900) is £45
(1901) £80
(1902) £145

leaving a larger margin for the purchase of apparatus, implements and materials during the first four than during subsequent years. The equipment could therefore be rendered fairly complete during the earlier years.

The plots of one stool and ten stools (*i.e.* during the first stages of the newly raised seedling canes) could not possibly be crushed in the estate mill and I suggest the purchase of a portable oil engine and a small (new or second hand) cane mill.

Cost of Oil Engine say £200
Mill say £50 £100

Chemicals and certain apparatus and implements would also be required.

7. The following outline plan of experiments is a maximum estimate and probably an over estimate of the number of plots which it will be possible to reap and analyse with present staff, consequently the estimate of loss and compensation for loss-involving experiments should be the maximum.

The experiments may be divided into

(a) Manurial Plots {Black Soil (Belle and Dodds) / Red soil (Hopewell)}

(b) Chemical selection Experiments.
Black Soil (Waterford)

(c) Cultivation of all known old Varieties

(d) Seedling Experiments {Main experiments / Red soil sub-experiments}

(e) Local Station Experiments.

The plan of Seedling Experiments *(d)* requires some explanation.

The first result of the germination of a cane seed and the planting out of the resulting seedling is the production of one stool of canes. From three acres (say 3,600 stools) [stage *(a')*] of such seedling canes planted out in the first year some 1000 would be found worth analysis and probably not more than 500 [stage *(b')*] of these would be considered worth propagation in 10 hole plots for reaping the following year, occupying 5000 stools = 4 acres about. Of these 500, it would probably be found advantageous to plant say 200 [stage *(c')*] in $\frac{1}{25}$ acre plots in black soil central station = 8 acres and 50 of the same varieties in the red soil sub-station $\frac{1}{25}$ acre plots = 2 acres. These 200 varieties would in like manner become reduced in the following planting to 100 varieties [stage *(d')*] each of $\frac{1}{25}$ acre and from this stage the varieties for local stations experiments would probably be selected. Thus:—

NUMBER OF VARIETIES.

1st planting	3600	single stools	3600	varieties stage	(a')
2nd „	500	10 stool plots	500	„	(b')

3rd	planting	200	$\frac{1}{25}$ acre	plots	200 varieties	(c)
4th	„	100	$\frac{1}{25}$ „	plots	100 „	(d)

This would be the history of a large number of seedlings planted the first year : in the second year, however, a similar number (3600) of seedlings would be planted out and a similar reducing selection would take place in subsequent years, so that two series would then be running. From the third year three series would be running and so on until the number of actual plots to reap was as large as could be managed.

During stage *(a)* I estimate a probable money loss of 75 per cent. on the area so planted. During stage *(b)* I estimate a probable loss of 50 per cent. on area so planted, and during stages *(c)*, *(d)*, etc., a probable loss of 30 per cent. on area so planted, assuming the actual price of sugar and molasses at £20 per acre this would mean stage *(a)* £15 per acre, stage *(b)* £10 per acre, and stages *(c)*, *(d)* etc., £6 per acre.

GENERAL TABULAR PLAN OF EXPERIMENTS.

The acreage is only roughly approximate and will vary with the lining used.

TO BE REAPED IN 1900.

No. of Samples for Analysis.	Where Planted.		Description.	Approx. acres.	Compensation.
1,000	Central Station	Series I Stage *a*	3,600 single stool seedlings	3 acres	£15
200	Central Station	Series I ..	200 Manurial plots (Black soil)	5 acres	.
100	Sub-central Red Soil Station	Series I	100 Manurial plots (Red soil) for ratooning .	2½ acres.	..
20	Central Station	Series I .	20 Chemical selection plots . ..	1 acre .	...
200	Dodds .		Varieties, etc., etc.	..	...
180	Local Stations ...		6 stations of 30 plots each .	...	..
1,700					£15

TO BE REAPED IN 1901.

No. of Samples for Analysis.	Where Planted.		Description.	Approx. acres.	Compensation.
1,000	Central Station	Series II Stage *a*	3,600 single stool seedlings	3 acres...	£45
400	Central Station	Series I Stage *b*	400 Black soil 10 stool plots ...	3½ acres..	£35
50	Sub-central Station ...	Series I Stage *b*	50 Red soil 10 stool plots ..		
200	Central Station	Series II...	200 Manurial plots (Black soil) ...	5 acres ...	...
100	Sub-central Station	Series I ...	100 Manurial ratoon plots (Red soil) ...	2½ acres..	...
20	Central Station	Series I ..	20 Chemical selection plots	1 acre ...	...
200	Dodds	..	Varieties, etc. ...	...	..
120	Local Stations	.	4 stations of 30 plots each	...	..
2,090					£80

TO BE REAPED IN 1902.

No of Samples for Analysis.	Where Planted.		Description.	Approx. acres.	Compensation.
1,000	Central Station	Series III Stage *a*	3,600 single stools seedlings	3 acres..	£45
400	Central Station	Series II Stage *b*	400 Black soil 10 stool plots ..	4 acres...	£40
50 50	Sub-central Station	Series I & II Stage *b*	50 Redsoil 10 stool plots ... ... 50 Ratoons ser. I		
200	Central Station	Series I Stage *c*	200 Black soil $\frac{1}{25}$ acre plots	8 acres...	£48
50	Sub-central Station	Series I Stage *c*	50 Red soil $\frac{1}{25}$ acre plots..	2 acres..	£12
200	Central Station	Series III	200 Manurial plots (black soil) ..	5 acres...	...
100	Sub-central Station . ..	Series I	100 Manurial 2nd ratoon plots (red soil)	2½ acres	...
20	Central Station	Series I	20 Chemical selection plots	1 acre ...	...
200	Dodds . ..	.	200 Varieties, &c. ...	..	...
120	Local Stations .	...	4 Stations of 30 ... plots each	...	
2,390					£145

TO BE REAPED IN 1903.

No of Samples for Analysis.	Where Planted.		Description.	Approx. acres.	Compensation.
1,000	Central Station	Series IV Stage *a*	3,600 single stool seedlings	3 acres...	£15
100	Central Station	Series III Stage *b*	400 Black soil 10 stool plots ..		
50	Sub-central Station ...	Series III Stage *b*	50 Red soil 10 stool plots ..	4 acres .	£10
50	Sub-central Station	Series II.. Stage *b*	50 Red soil Ratoons		
50	Sub central Station . ..	Series I... Stage *b*	50 ,, 2nd Ratoons		
200	Central Station	Series I & II Stages *c* & *d*	200 Black soil $\frac{1}{25}$ acre plots ..	8 acres .	£18
50	Sub-central Station . .	Series I & II Stages *c* & *d*	50 Red soil $\frac{1}{25}$ acre plots	2 acres.	£12
200	Central Station	Series III	200 Manurial plots black soil ...	5 acres .	...
100	Sub central Station	Series I	100 Manurial 3rd ratoons ...	$2\frac{1}{2}$ acres	...
20	Central Station	Series I .	20 Chemical selection plots .	1 acre ..	...
200	Dodds .. .		Varieties etc. ..	...	
120	Local Stations	..	4 Stations of 30 plots each ..		..
2,440					£145

In the year, 1903, the number of plots reaped would reach the constant maximum and although the number of $\frac{1}{25}$ acre plots would increase in subsequent years at the expense of some of the smaller ones and therefore the compensation area increase, I estimate that the compensation would never exceed £200.

The classification of the plots in the Red soil sub-central. is only roughly indicated, as the ratooning introduces complications unnecessary to include in this tabular plan.

It will be understood that the general plan which I indicate above would necessarily be subject to modifications, perhaps very extensive, the result of experience. For we should profit by knowledge gained as the experiments proceeded and new and profitable lines of enquiry might possibly suggest themselves to the partial exclusion of older ones.

I have, etc..

(Signed) J. P. D'ALBUQUERQUE,
Island Professor of Chemistry
and Agricultural Science.

Note to letter of November 25th, 1898.—By kind permission of Sir Geo. Pile, Attorney, and Mr. James Hawkins, Manager, the "Belle" plantation situate about 2 miles from Bridgetown, the property of the Earl of Harewood, has been added to the list of central stations, a very level field of about 8 acres has been utilised for manurial experiments detailed in my letter of 29th December, and a large number of seedling cane plots have been established.

Note 2. It has been determined, with the consent of the Commissioner of Agriculture, to erect the oil-engine and mill at the Government Laboratory, where samples of 100 or 200lbs. of each plot of canes grown at local and central stations will be sent to be crushed and analysed.

MANURIAL EXPERIMENTAL PLOTS.

Government Laboratory,
Barbados, 29th December, 1898.

Sir,

I have the honour to forward the following description of the manurial applications which I propose for the manurial Experimental plots at the "Belle" plantation.

(2) The area, uniform and level, in the field known as Salt" field available for these experiments is between seven and a half and eight acres,

(3) The size of each plot I propose to be 40 holes, i.e. approximately one-thirtieth of an acre, the lining being 6 x 6 Each plot occurs in each of three series.

(4) In nearly every case I propose to divide each of these plots into two equal parts, the difference between the two parts being generally one in regard to the time at which the manures are to be applied.

(5) The chief questions, briefly put, that these experiments are expected to answer are

> (*a*) Does the manurial application of nitrogen $\frac{\text{and}}{\text{or}}$ phosphoric acid $\frac{\text{and}}{\text{or}}$ potash lead to an increased return of sugar and profit? (*b*) What is the most favourable quantity of each or any of these constituents to apply? (*c*) What is the best form in which to apply each manurial constituent? (*d*) What is the most favourable time or times for applying any manurial constituent? (*e*) Are any of the replies to the foregoing questions affected by differences of rainfall or other differences of climatic conditions in different years? &c., &c.

(6) The following list details the composition of the manures and times of application of the constituents thereof for each plot of series A. The plots of series B and series C

are respectively identical with those of series A except in regard to their position in the field. In each series there are 76 plots (exclusive of control plots) most of which are divided into two equal parts: there are therefore (67 × 3) about 201 double plots of 40 holes each, which, including control plots, cover 7½ acres approximately.

List of Experimental Plots (Manurial) Series A.

Control Plots.

Upper Half.	Lower Half.
* No Manure.	* Farmyard Manure 20 tons per acre.
* "Chemical Manure" consisting of 75 lbs. Nitrogen ⅓ early, ⅓ late, ⅓ late. 100 lbs. Basic Slag Phosphate early. 75 lbs. Potash ⅔ early, ⅓ late.	* Farmyard Manure 20 tons per acre and "Chemical Manure" consisting of 75 lbs. Nitrogen ⅓ early, ⅓ late, ⅓ late. 100 lbs. Basic Slag Phosphate early, 75 lbs. Potash ⅔ early, ⅓ late.

Nitrogen Sub-series.

Upper Half.	Lower Half.
* 1. 50 lbs. Phosphates as Superphosphate (½ early, ½ late.) Potash (⅔ early, ⅓ late.	* 2. Cinereals I. (50 lbs. Potash ⅔ early, ⅓ late) (100 Basic Slag Phosphate early.)

Nitrogen Sub-series.—Continued.

Upper Half.	Lower Half.
3. 100 lbs. Phosphates as Superphosphate (½ early, ½ late.) 100 lbs. Potash (⅔ early, ⅓ late.	4. Cinereals II. (100 lbs. Potash ⅔ early, ⅓ late. (200 lbs. Basic Slag Phosphate early.)
*	*
13. 50 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.)	14. 50 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.)
*	*
15. 75 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.)	16. 75 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.)
*	*
17. 100 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.)	18. 100 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.)
*	*
19. 50 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.) Cinereals I.	20. 50 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.) Cinereals I.
*	*
21. 75 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.) Cinereals I.	22. 75. lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.) Cinereals I.

Nitrogen Sub-series.—Continued.

Upper Half.	Lower Half.
* 23. 100 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.) Cinereals I.	* 24. 100 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.) Cinereals I.
25. 50 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.) Cinereals II.	26. 50 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.) Cinereals II.
27. 75 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.) Cinereals II.	28. 75 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.) Cinereals II.
29. 100 lbs. Nitrogen as Sulphate Ammonia (⅓ early, ⅓ late, ⅓ late.) Cinereals II.	30. 100 lbs. Nitrogen as Sulphate Ammonia (½ late, ½ late.) Cinereals II.
* 31. 50 lbs. Nitrogen as Nitrate Soda (⅓ early, ⅓ late, ⅓ late.)	* 32. 50 lbs. Nitrogen as Nitrate Soda (½ late, ½ late.)
* 33. 75 lbs. Nitrogen as Nitrate Soda (⅓ early, ⅓ late, ⅓ late.)	* 34. 75 lbs. Nitrogen as Nitrate Soda (½ late, ½ late.)

Nitrogen Sub-series.—Continued.

Upper Half.	Lower Half.
* 35. 100 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.)	* 36. 100 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{2}$ late, $\frac{1}{2}$ late.)
* 37. 50 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{3}$ early, $\frac{1}{3}$ late. $\frac{1}{3}$ late.) Cinereals I.	* 38. 50 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{2}$ late. $\frac{1}{2}$ late.) Cinereals I.
* 39. 75 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) Cinereals I.	* 40. 75 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{2}$ late, $\frac{1}{2}$ late.) Cinereals I.
* 41. 100 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) Cinereals I.	* 42. 100 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{2}$ late, $\frac{1}{2}$ late.) Cinereals I.
43. 50 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) Cinereals II.	44. 50 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{2}$ late, $\frac{1}{2}$ late.) Cinereals II.
45. 75 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) Cinereals II.	46. 75 lbs. Nitrogen as Nitrate of Soda ($\frac{1}{2}$ late, $\frac{1}{2}$ late.) Cinereals II.

Nitrogen Sub-series—Continued.

Upper Half.	Lower Half.
47. 100 lbs. Nitrogen as Nitrate of Soda (1/3 early, 1/3 late, 1/3 late.) Cinereals II.	48. 100 lbs. Nitrogen as Nitrate of Soda (1/2 late, 1/2 late.) Cinereals II.
*	*
49. 50 lbs. "Nitrogen" (1/3 early, 1/3 late, 1/3 late.) Cinereals I.	50. 50 lbs. "Nitrogen" (1/2 late, 1/2 late.) Cinereals I.
*	*
51. 75 lbs. "Nitrogen" (1/3 early, 1/3 late, 1/3 late.) Cinereals I.	52. 75 lbs. "Nitrogen" (1/2 late, 1/2 late.) Cinereals I.
*	*
53. 100 lbs. "Nitrogen" (1/3 early, 1/3 late, 1/3 late.) Cinereals I.	54. 100 lbs. "Nitrogen" (1/2 late, 1/2 late.) Cinereals I.
*	*
55. 50 lbs. "Nitrogen" (1/3 early, 1/3 late, 1/3 late.) Cinereals II.	56. 50 lbs. "Nitrogen" (1/2 late, 1/2 late.) Cinereals II.
*	*
57. 75 lbs. "Nitrogen" (1/3 early, 1/3 late, 1/3 late.) Cinereals II	58. 75 lbs. "Nitrogen" (1/2 late, 1/2 late.) Cinereals II.

Nitrogen Sub-series—Concluded.

Upper Half.	Lower Half.
* 59. 100 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) Cinereals II.	* 60. 100 lbs. "Nitrogen" ($\frac{1}{2}$ late, $\frac{1}{2}$ late.) Cinereals II.

Phosphate Sub-series.

Upper Half.	Lower Half.
* 5. (Nitrogen and Potash) I. (50 lbs. "Nitrogen" $\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) (50 lbs. Potash, $\frac{2}{3}$ early, $\frac{1}{3}$ late.)	7. (Nitrogen and Potash) II. (100 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) (100 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.)
8. (Nitrogen and Potash) II.	* 6. (Nitrogen and Potash) I.
61. 50 lbs. Basic Slag Phosphate (early.)	62. Lime (early.)
63. 100 lbs. Basic Slag Phosphate (early.)	64. Lime (early.)

Phosphate Sub-series—Continued.

Upper Half.	Lower Half.
* 65. 200 lbs. Basic Slag Phosphate (early.)	* 66. Lime (early.)
* 67. 50 lbs. Basic Slag Phosphate (early.) (Nitrogen and Potash) I.	* 68. Lime (early.) (Nitrogen and Potash) I.
* 69. 100 lbs. Basic Slag Phosphate (early.) (Nitrogen and Potash) I.	* 70. Lime (early.) (Nitrogen and Potash) I.
* 71. 200 lbs. Basic Slag Phosphate (early.) (Nitrogen and Potash) I.	* 72. Lime (early.) (Nitrogen and Potash) I.
73. 50 lbs. Basic Slag Phosphate (early.) (Nitrogen and Potash) II.	74. Lime (early.) (Nitrogen and Potash) II.
75. 100 lbs. Basic Slag Phosphate (early.) (Nitrogen and Potash) II.	76. Lime (early.) (Nitrogen and Potash) II.

Phosphate Sub-series—Continued.

Upper Half.	Lower Half.
77. 200 lbs. Basic Slag Phosphate (early.) (Nitrogen and Potash) II.	78. Lime (early.) (Nitrogen and Potash) II.
79. 50 lbs. Phosphate as Superphosphate (early.)	80. 50 lbs. Phosphate as Superphate (early.) Lime (early.)
81. 75 lbs. Phosphate as Superphosphate (early.)	82. 75 lbs. Phosphate as Superphosphate (early.) Lime (early.)
83. 100 lbs. Phosphate as Superphosphate (early.)	84. 100 lbs. Phosphate as Superphosphate (early.) Lime (early.)
* 85. 50 lbs. Phosphate as Superphosphate (early.) (Nitrogen and Potash) I.	* 86. 50 lbs. Phosphate as Superphosphate (½ early, ½ late.) (Nitrogen and Potash) I.
* 87. 75 lbs. Phosphate as Superphosphate (early.) (Nitrogen and Potash) I.	* 88. 75 lbs. Phosphate as Superphosphate (½ early, ½ late.) (Nitrogen and Potash) I.

Phosphate Sub-series—Concluded.

Upper Half.	Lower Half.
*	*
89. 100 lbs. Phosphate as Superphosphate (early.) (Nitrogen and Potash) I.	90. 100 lbs. Phosphate as Superphosphate (½ early, ½ late.) (Nitrogen and Potash) I.
91. 50 lbs. Phosphate as Superphosphate (early.) (Nitrogen and Potash) II.	92. 50 lbs. Phosphate as Superphosphate (½ early, ½ late.) (Nitrogen and Potash) II.
93. 75 lbs. Phosphate as Superphosphate (early.) (Nitrogen and Potash) II.	94. 75 lbs. Phosphate as Superphosphate (½ early, ½ late.) (Nitrogen and Potash) II.
95. 100 lbs. Phosphate as Superphosphate (early.) (Nitrogen and Potash) II.	96. 100 lbs Phosphate as Superphosphate (½ early, ½ late.) (Nitrogen and Potash) II.

Potash Sub-series.

Upper Half.	Lower Half.
*	*
9. 50 lbs. "Nitrogen" (⅓ early, ⅓ late, ⅓ late.) 50 lbs. Phosphate as Superphosphate (½ early, ½ late.)	10. (Nitrogen and Phosphate) I. (50 lbs. "Nitrogen" ⅓ early, ⅓ late, ⅓ late.) (100 lbs. Basic Slag Phosphate (early.)

Potash Sub-series—Continued.

Upper Half.	Lower Half.
11. 100 lbs. "Nitrogen" (⅓ early, ⅓ late) 100 lbs. Phosphate as Superphosphate (½ early, ½ late.)	12. (Nitrogen and Phosphate) II. (100 lbs. "Nitrogen" ⅓ early, ⅓ late, ⅓ late.) (200 lbs. Basic Slag Phosphate early.)
97. 50 lbs. Potash (early.)	98. 50 lbs. Potash (⅔ early, ⅓ late.)
99. 75 lbs. Potash (early.)	100. 75 lbs. Potash (⅔ early, ⅓ late.)
101. 100 lbs. Potash (early.)	102. 100 lbs. Potash (⅔ early, ⅓ late.)
* 103 50 lbs. Potash (early.) (Nitrogen and Phosphate) I.	* 104. 50 lbs Potash (⅔ early, ⅓ late.) (Nitrogen and Phosphate) I.
* 105. 75 lbs. Potash (early). (Nitrogen and Phosphate) I.	* 106. 75 lbs Potash (⅔ early, ⅓ late.) Nitrogen and Phosphate) I.

Potash Sub-series Concluded.

Upper Half.	Lower Half.
*	*
107. 100 lbs. Potash (early.) (Nitrogen and Phosphate) I.	108. 100 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) (Nitrogen and Phosphate) I.
109. 50 lbs. Potash (early.) (Nitrogen and Phosphate) II.	110. 50 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) (Nitrogen and Phosphate) II.
111. 75 lbs. Potash (early.) (Nitrogen and Phosphate) II.	112. 75 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) (Nitrogen and Phosphate) II.
113. 100 lbs. Potash (early.) (Nitrogen and Phosphate) II.	114. 100 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) (Nitrogen and Phosphate) II.

Miscellaneous Sub-series.

Upper Half.	Lower Half.
115. 50 lbs. Phosphate as Superphosphate (early.) 50 lbs. Potash (early.) 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.)	116. 50 lbs. Phosphate as Superphosphate (early 50 lbs. Potash (early.) 50 lbs. "Nitrogen" ($\frac{1}{2}$ late, $\frac{1}{2}$ late.)

Miscellaneous Sub-series—Continued.

Upper Half.	Lower Half.
117. 50 lbs. Phosphate as Superphosphate ($\frac{1}{2}$ early, $\frac{1}{2}$ late.) 50 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.)	118. 50 lbs. Phosphate as Superphosphate ($\frac{1}{2}$ late, $\frac{1}{2}$ late.) 50 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) 50 lbs. "Nitrogen" ($\frac{1}{2}$ late, $\frac{1}{2}$ late.)
119. 50 lbs. Phosphate as Superphosphate (late.) 50 lbs. Potash (late.) 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.)	120. 50 lbs. Phosphate as Superphosphate (late.) 50 lbs. Potash (late.) 50 lbs. "Nitrogen" ($\frac{1}{2}$ late, $\frac{1}{2}$ late.)
121. 100 lbs. Basic Slag Phosphate (early.) 50 lbs. Potash (late.) 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.)	122. 100 lbs. Basic Slag Phosphate (early.) 50 lbs. Potash (late.) 50 lbs. "Nitrogen" ($\frac{1}{2}$ late, $\frac{1}{2}$ late.)
123. 100 lbs. Basic Slag Phosphate (early.) 50 lbs. Potash (early.) 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.)	124. 100 lbs. Basic Slag Phosphate (early.) 50 lbs. Potash (early.) 50 lbs. "Nitrogen" ($\frac{1}{2}$ early, $\frac{1}{2}$ late.)
125. 50 lbs. Phosphate as Superphosphate (early.) 50 lbs. Potash (late.) 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.)	126. 50 lbs. Phosphate as Superphosphate (early.) 50 lbs. Potash (late.) 50 lbs. "Nitrogen" ($\frac{1}{2}$ late, $\frac{1}{2}$ late.)
127. 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) 50 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) Lime (early.)	128. 50 lbs. "Nitrogen" ($\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.) 50 lbs. Potash ($\frac{2}{3}$ early, $\frac{1}{3}$ late.) 100 lbs. Basic Slag Phosphate (early.)

Miscellaneous Sub-series—Concluded.

Upper Half.	Lower Half.
129. 100 lbs. "Nitrogen" (⅓ early, ⅓ late, ⅓ late.) 100 lbs. Potash (⅔ early, ⅓ late.) Lime (early.)	130. 100 lbs. "Nitrogen" (⅓ early, ⅓ late, ⅓ late.) 100 lbs. Potash (⅔ early, ⅓ late.) 200 lbs. Basic Slag Phosphate (early.)
131. 50 lbs. "Nitrogen" (⅓ early, ⅓ late, ⅓ late.) 50 lbs. Potash (⅔ early, ⅓ late.) 50 lbs. Phosphate as Superphosphate (½ early, ½ late.) Lime (early.)	132. 50 lbs. "Nitrogen" (⅓ early, ⅓ late, ⅓ late.) 50 lbs. Potash (⅔ early ⅓ late.) 50 lbs. Phosphate as Superphosphate (½ early, ½ late.)
133. 100 lbs. "Nitrogen" (⅓ early, ⅓ late, ⅓ late.) 100 lbs. Potash (⅔ early, ⅓ late.) 100 lbs. Phosphate as Superphosphate (½ early, ½ late.) Lime (early.)	134. 100 lbs. "Nitrogen" (⅓ early, ⅓ late, ⅓ late.) 100 lbs. Potash (⅔ early, ⅓ late.) 100 lbs. Phosphate as Superphosphate (½ early, ½ late.)

(7.) Certain plots are marked thus *. These plots I propose should constitute the Red soil manurial experiments at "Hopewell." The lining employed at that plantation is 6 × 4, and each plot will cover one-thirtieth of an acre. There will thus be three series each of 29 double plots (exclusive of control plots) of Red soil manurial experiments, amounting to a total of 87 double plots, and covering, with control plots, about 3½ acres.

(8) Control Plots.—I propose to employ a system of "control plots" for comparison with the other experimental plots in the field; they will be grouped in nests, each nest consisting of four half-plots arranged as follows:—

No manure plot.
Chemical manure plot. (consisting of an application of "Nitrogen," Phosphate & Potash.)

Farmyard manure plot.
Farmyard and chemical manure plot.

The relative position of these four half-plots will vary in the different nests in different parts of the field. There will be about 24 such nests at the "Belle" in the whole field, and it is hoped by this means, which is a modification of the method instituted in British Guiana by Professor Harrison, to be able to eliminate in a great measure the errors due to difference

of fertility in differents parts of the field. A similar system and arrangement will be employed at "Hopewell."

(9) EXPLANATION OF CERTAIN TERMS USED.—"Nitrogen," without the form being named, signifies "Nitrogenous application consisting of Nitrogen in the form of $\frac{2}{3}$ Sulphate of Ammonia and $\frac{1}{3}$ Nitrate of Soda."

"Potash" means "Potash in the form of Sulphate of Potash."

"Early, late, late," means that the constituent is applied in three parts—say—"January, June, September."

"Late, late" is similarly equivalent to "in June and September."

"Early" is equivalent to "in January."
"Late" is equivalent to "in June."

"Cinereals I." means:—	50 lbs.	Potash $\frac{2}{3}$ early, $\frac{1}{3}$ late.
	100 ,,	Basic Slag Phosphate early.
"Cinereals II." means:—	100 ,,	Potash $\frac{2}{3}$ early, $\frac{1}{3}$ late.
	200 ,,	Basic Slag Phosphate early.
"(Nitrogen and potash)" I. means:—	50 ,,	Nitrogen $\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.
	50 ,,	Potash $\frac{2}{3}$ early, $\frac{1}{3}$ late.
"(Nitrogen and potash) II." means:—	100 ,,	"Nitrogen" $\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.
	100 ,,	Potash $\frac{2}{3}$ early, $\frac{1}{3}$ late.
"(Nitrogen & phosphate) I." means:—	50 ,,	"Nitrogen" $\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.
	100 ,,	Basic Slag Phosphate early.
"(Nitrogen & phosphate) II." means:—	100 ,,	"Nitrogen" $\frac{1}{3}$ early, $\frac{1}{3}$ late, $\frac{1}{3}$ late.
	200 "	Basic Slag Phosphate early.

Notes. (*a*) The Sulphate of Ammonia and Nitrate of Soda if applied together should be applied soon after mixing.

(*b*) The Basic Slag, and Lime, which in all cases are marked early, should be applied sometime, say a fortnight, before any manure containing Sulphate of Ammonia.

I have, etc.,

(Signed) J. P. d'ALBUQUERQUE.

Island Professor of Chemistry and Agricultural Science and Chemist in charge of Sugar cane Experiments.

Dr. D. MORRIS, C.M.G., M.A., D.Sc., F.L.S., &c.
Commissioner of Agriculture for the West Indies.

EXPERIMENT STATION.

Botanic Station,
Codrington House,
24th July, 1899.

Sir,

In accordance with your instructions, I have the honour to submit the following report on the sugar cane experiments inaugurated in this colony under the auspices of the Imperial Department of Agriculture for the West Indies.

2. Previous to the establishment of the Department of Agriculture, sugar cane experiments to a limited extent had been carried on at the Botanic Station at Dodds for some 14 years and it was decided on your arrival to extend these experiments as far as the funds at your disposal for the purpose permitted.

3. As you are aware, owing to the depressed financial condition of the colony, it was further decided, instead of asking the Barbados Government to purchase an estate for an experiment station, to ask the planters to allow the experiments to be conducted on their estates. It was also decided at the same time that in selecting the stations care should be taken to obtain them in such localities as represented the varying soil and climatic conditions of the island, and also, as the plots would form fields of illustration, to distribute them as much as possible so that the planters might see for themselves the growth of the canes best suited to their districts, and, in the localities where the manurial plots were established, the effect of the manure having the greatest influence on the yield of one of the best varieties of the sugar-cane.

4. Such being the lines on which it was decided that the experiments should be conducted, permission was sought and obtained for carrying on experiments with different varieties at ten stations including Dodds, Oughtersons, and Sunbury, the estates on which experiments had been previously conducted, and with manurial experiments on three stations including Dodds.

5. The following is a list of these stations giving the

average rainfall of the district for the past 5 years, the approximate height above sea level, the colour of the soil etc. :—

LIST OF MANURIAL, CENTRAL AND LOCAL STATIONS IN BARBADOS.

Parish.	Name of Estate.	Colour of Soil.	Approximate Elevation.	Average rainfall of district for 5 years.	Owner or Attorney.	Manager.	REMARKS.
St. Philip ...	Dodds ...	Black	210	62·07	Govt. of B'bados	E. L. Skeete ...	Central, local and manurial.
„ ...	Oughtersons	Black	291	62·07	Jos. Connell ...	Jos. Connell ...	Local Station.
„ ...	Sunbury ...	Black	160	62·07	A. Cameron ...	W. C. Hutson ...	Local Station.
„ ...	Hampton ...	Black	103	62·07	A. Cameron ...	W. C. Hutson ...	Local Station.
St. Michael	Waterford ...	Black	180	61·69	Collymore Bros.	E. W. Mahon ...	Central and Local Station.
„ ...	Pine ...	Black	150	61·69	J. C. Lynch ...	W. Walcott ...	Local Station.
„ ...	Belle ...	Black	140	61·69	Sir G. C. Pile ...	Jas. Hawkins ...	Manurial Station.
Ch. Church	Coverley ...	Black	254	63·92	Thos. Clarke ...	Hon. F. J. Clarke	Local Station.
St. John ...	Henley ...	Red	553	76·11	T. S. Skeete ...	W. E. Farmer ...	Local Station.
St. Joseph...	Blackmans ...	Red	910	86·05	George A. Sealy	M. Greenidge ...	Local Station.
St. Thomas	Hopewell ...	Red	534	77·61	F. G. Inniss ...	F. G. Inniss ...	Manurial Station.
St. Lucy ...	Husbands ...	Black	184	66·21	T. S. Skeete ...	H. A. Bovell ...	Local Station.

6. The experiment stations may be said to be divided into three series, manurial stations, central stations, and local stations. The manurial stations are for testing the action of different manurial compounds on one of the best varieties of the sugar cane under the varying soil and climatic conditions of the different districts in which the stations are situated. The central stations are for cultivating seedling canes, until they reach such a stage as will justify their being distributed to the local stations. On these local stations experiments will be conducted with the best of the different varieties of the sugar cane, obtained principally from seedling canes grown in this and other colonies, so as to ascertain the best cane suited to the various districts.

7. Having obtained the necessary permission for instituting the experiments, the work was commenced on the 1st December 1898 and proceeded with—with a slight intermission during the time I was engaged in Antigua and St. Kitts on similar work—until completed.

8. Including the seedling canes of the first year's growth there are 4,675 experiments at present being carried on, and are distributed as follows, viz.:—

Experiments with manures—

Dodds	26
Belle	480
Hopewell	206
	712

Experiments with the best of the different varieties of the sugar cane—

Waterford	21
Coverley	20
Pine	34
Henley	20
Blackmans	20
Husbands	20
	135

Experiments with seedling sugar canes of the 2nd, 3rd and 4th year's growth—

Dodds	117
Oughterson	16
Sunbury	19
Hampton	10
	162

Experiments with seedling sugar canes of the first year's growth—

Waterford	3,666

Making a total altogether of 712 experiments with different manures and 3,963 experiments with different canes.

Experiments with ten of the best varieties, viz. B. No. 147, D. No. 145, B. No. 156, B. No. 306, B. No. 208, B. No. 254, D. No. 130, B. No. 347, Jamaica Cane and Rock Hall cane are being repeated on estates in six different districts.

In addition to the experiments mentioned above, there are at Waterford five clumps of canes growing from cuttings taken from the specimen of bud variation sent you by the Hon. F. J. Clarke, who obtained it from Kirton Plantation. Three of the clumps are from the "sports," the other two are from the growing buds, which were like the parent cane.

As it may be of interest I have annexed herewith, plans of the fields at the different manurial experiment stations shewing the position of the plots and the quantities of nitrogen, phosphates, and potash applied to each plot, and a sketch map of the island shewing where the various stations are located. *

I have, etc.,

(Sgnd.) JOHN R. BOVELL,
Superintendent.

Dr. D. MORRIS, C.M.G., D.Sc., F.L.S. &c.
Commissioner of Agriculture for the West Indies.

SOME EXPERIENCES WITH SEEDLING CANES IN BRITISH GUIANA.

BY F. J. SCARD, F. I. C.

In putting forward the following brief account of the experiences of the New Colonial Company with seedling canes, I am not dealing with varieties other than those which have already attracted attention, but am rather endeavouring to show their behaviour, especially in relation to the Bourbon, under the somewhat rigorous conditions of estate cultivation. This is a phase of the question which has not, I fancy, received much attention under experimental conditions, or to which, at any rate, much publicity has not been given.

The necessity for this crucial test is obvious, and no new variety of cane can be accepted, until it has satisfactorily passed through it. It has been to this end, therefore, that observations have been conducted at "Plantation Peter's Hall" during the last 15 years, as a supplement to the exhaustive work carried on at the Botanic Gardens, Georgetown, in the first instance, under the control of Messrs. Jenman and Francis, and on the death of the latter, of Messrs. Jenman and Harrison.

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*These plans are too voluminous to be reproduced in these pages.
[ED. W. I. B.]

Between 1881 and 1886 upwards of 46 known varieties of cane had been experimented on at the Botanic Gardens, and in the latter year a nursery for the most promising of these was started at "Plantation Peter's Hall" with the view of keeping them under observation with the ultimate intention of including the best of them for comparison with the Bourbon in the general cultivation. Towards the end of 1889 these were augmented by seedlings brought from Barbados by Professor Harrison and later with some supplied by Mr. Bovell from "Dodds."

The varieties brought by Professor Harrison were the following:—Burke, Governor Lees, Armstrong, Jenman, and Harrison. The seedlings obtained later from Barbados were numbered from one to twenty.

The results of the nursery experience with these were disappointing. Of the whole, the only variety to which it was judged worth while to apply the test of field cultivation was the "Scard" cane. This was a seedling given me by Mr. Bovell, who was then at "Dodds," in 1890, and the subsequent history of this cane is extremely interesting, as shewing how exuberantly vital in early years a seedling may be, and how quickly its characteristics may become subsequently modified.

On arrival at Demerara, this seedling was handed over to Mr. Jenman, who, in 1890, refers to it as having *forty-seven canes* to the stool, of an average length of fifteen feet, and weighing altogether, when cleaned, *six hundred and fifty pounds*. Under these circumstances, the outlook for this cane was most promising.

The experience in the general cultivation was not, however, satisfactory. It lost, to a very great extent, its vigorous character, and, although, to the end, it gave a somewhat heavier yield of cane than the Bourbon, the poverty of its juice more than neutralised this advantage.

No cane up to this time having been found to be superior to the Bourbon, the experimental work at "Peter's Hall" was suspended until the Botanic Gardens' experience showed some decisive evidence of the discovery of a cane worth further trial.

In 1896, Messrs. Jenman and Harrison felt themselves to be in a position to strongly advocate Nos. 95, 78, 74, 145, 115, 109, 102, and were able to supply sufficient cane to give definite cultivation results, without the necessity for preliminary nursery propagation. Plots of the above were, therefore, planted out at "Peter's Hall" and arranged so as to give actual comparison with the Bourbon. During the thirteen months—June to July—of their growth, these canes experienced an exceptionally heavy rainfall, which produced a ripening effect, necessitating their being cut at this age, instead of being left over in the ordinary course until October. The ordinary manuring of the estate, sulphate of ammonia and insoluble phosphate, was adopted.

The canes of the several plots were weighed before being loaded into the punts, and the megass on its way to the fur-

naces, the latter being part of the ordinary routine of the factory. The crushing was effected with a single three roller mill, giving with average canes about 2,400 gallons per hour. The juice was collected for analysis at intervals of five minutes. *The results of the crushing were as follows :—*

Description.	Cane. Tons per acre.	Juice. Gallons per acre.	Sugar. Yielded per acre in juice tons.	% Crushing.	Composition of Juice. Sp. gr.	Cane Sugar. lbs. per gallon.	Glucose. lbs. per gallon.	Cane Sugar Quot:	Glucose Quot:	Non-Sugar Quot:
No. 78	40·4	5,858	3·61	68·8	1·0625	1·383	·139	75·1	8·0	16·9
„ 145	42·5	5,525	3·49	63·8	1·0625	1·419	·125	83·4	7·3	9·3
„ 95	37·0	5,031	3·42	64·7	1·0658	1·524	·080	85·0	4·4	10·6
„ 74	33·7	4,356	3·15	61·8	1·0692	1·620	·048	86·1	2·5	11·4
„ 109	40·0	5,290	2·95	62·6	1·0584	1·252	·121	78·8	8·2	12·0
Bourbon I	32·9	4,650	2·93	67·1	1·0633	1·415	·108	82·1	6·2	11·7
No. 102	31·2	4,340	2·82	66·0	1·0650	1·456	·086	82·3	4·7	13·0
Bourbon II	30·0	4,381	2·81	65·2	1·0633	1·438	·086	83·4	5·0	11·6
No. 115	30·5	3,848	2·66	60·0	1·0675	1·555	·069	84·1	3·8	12·1

It may be mentioned that considerable difficulty was experienced in milling No. 115, the brittle, thin rind snapping at the joints and causing much trouble in the feeding. Compared with the Bourbon yield, the above stand as follows :—

No. 78	...	125
„ 145	...	122
„ 95	...	119
„ 74	...	109
„ 109	...	103
Bourbon	...	100
No. 102	...	99
„ 115	...	93

It will be noticed that the juice of some of the numbers, notably 95 and 74, showed evidence of much greater maturity

than that of others, especially 78 and 109. This question of age is an important one with seedling canes, as a cane which requires, say fifteen months' growth to arrive at maturity would be quite unfitted for a locality where climatic conditions only admit of ten months.

Prior to the results under consideration, as must necessarily follow with nursery work, the canes had been judged by their laboratory behaviour, and it was thought the present would afford an excellent opportunity for ascertaining how far this would be in accord with actual factory milling. To this end, each plot was sampled as carefully as possible, and the canes thus selected crushed in a laboratory mill.

The following were the figures obtained :—

CANE SUGAR, LBS. PER GALLON, IN JUICE FORM.

	Estate Mill.	Laboratory Mill.
No. 95	1·524	1·636
„ 78	1·383	1·545
„ 109	1·252	1·905
Bourbon I	1·435	2·150
Bourbon II	1·438	1·983
No. 74	1·620	2·066
„ 102	1·456	1·720
„ 145	1·419	1·597
„ 115	1·555	1·899

I was prepared to find the sugar content of the laboratory juice higher than that of the factory, but certainly did not expect the complete want of relation noticed. There can be no doubt that this is due to the impossibility of satisfactorily sampling a bed, much less a field, of canes and it is on this account that I lay so much stress on the necessity for not accepting any new variety until it has been cultivated on a scale sufficient to admit of the canes being dealt with on a factory scale of work.

With the tops from the five varieties which shewed better yield than the Bourbon, a fresh and more extensive series (B) was started, while the canes in (A) were carried on as first ratoons. The spring was excellent, but a severe drought during the early months of 1899 checked growth much, and when the plots were cut again in May of that year, want of length of cane had brought about a much lessened tonnage, partly compensated for, however, by the unusual quality of the juice. The following results were now obtained. It will be observed that some alterations of relative position had taken place

A. *Second Reaping.*

Description.	Cane. Tons per acre.	Juice. Gallons per acre.	Sugar. Yielded per acre in juice tons.	% Crushing.	Composition of Juice. Sp. Gr.	Cane Sugar. lbs. per gallon.	Glucose. lbs. per gallon.	Cane Sugar Quot:	Glucose Quot:	Non-Sugar Quot:
No. 95	18·93	2,658	2·70	68·4	1·0920	2·257	·027	90·5	1·1	8·4
„ 78	24·54	3,348	2·67	68·2	1·0785	1·790	·083	83·8	3·9	12·3
„ 109	24·40	3,219	2·47	64·1	1·0789	1·719	·039	83·2	1·9	14·9
Bourbon I	16·58	2,355	1·92	68·4	1·0785	1·833	·039	85·8	1·8	12·34
No. 74	18·58	2,489	2·26	64·9	1·0854	2·037	·034	87·7	1·5	10·8
„ 102	16·04	2,274	2·00	68·64	1·0837	1·977	·040	86·8	1·7	11·5
„ 145	18·48	2,450	2·19	64·1	1·0837	2·011	·078	88·4	3·4	8·2
Bourbon II	19·97	2,810	2·26	67·9	1·0776	1·805	·091	85·5	4·3	10·2
No. 115	15·70	1,990	1·75	61·2	1·0828	1·974	·036	87·6	1·6	10·7

Compared with the Bourbon taken as 100, the yields were as follows:—

No. 95	129
„ 78	127
„ 109	118
„ 74	108
„ 145	105
Bourbon	100
No. 102	95
„ 115	83

After cutting, the stools sprang freely, but a severe drought setting in in August, and practically continuing until the end of December, but little growth occurred. Nos. 95, 74 and 115, however, arrowed freely in November, and as this tendency to early arrowing was sufficient in itself to condemn the cane for British Guiana purposes, it was decided to abandon the cultivation of these varieties.

As already mentioned, when the first cutting of the "A" plots took place, the five varieties which excelled the Bourbon, were planted out on a larger scale. These underwent the same severe climatic conditions as the canes during the second year of the "A" plots, and suffered accordingly. The Bourbon, however, in this case stood its ground well.

B. *First Reaping.*

Description.	Canes. Tons per acre.	Juice. Gallons per acre.	Sugar. Yielded per acre in juice tons	% Crushing.	Composition of Juice. Sp. Gr.	Cane sugar. lbs. per gallon.	Glucose. lbs. per gallon.	Cane sugar Quot:	Glucose Quot:	Non-sugar Quot:
No. 74	21·01	2,758	2·20	62·5	1·0768	1·790	·039	85·6	1·9	12·5
„ 109	19·27	2,409	1·87	60·0	1·0751	1·739	·057	85·1	2·8	12·1
„ 78	17·02	2,353	1·78	66·3	1·0742	1·696	·050	84·0	2·5	13·5
„ 95	10·9	1,421	1·15	62·7	1·0776	1·816	·030	86·0	1·5	12·5
„ 145	17·37	2,321	1·83	64·2	1·0751	1·767	·068	86·5	3·4	13·14
Bourbon	20·35	3,047	2·34	66·9	1·0751	1·724	·078	84·5	3·8	11·77

The relative yield was thus as follows:—

Bourbon	100
No. 74	94
„ 109	80
„ 145	78
„ 78	76
„ 95	49

Here is a complete reversal of the former results. In series "A" the above five numbers in both years were ahead of the Bourbon, in this instance all below No. 95 taking an exceptionally poor position. The fields in which "A" and "B" were planted were adjacent, separated only by trench and dam, the cultivation, manuring, drainage and climatic conditions the same, the same scientific care taken to secure experimental accuracy. Yet no results could be more contradictory than those of "A" and "B."

The above canes were cut in May, sprang well but were subsequently subjected to the same severe drought as has been already mentioned in the instance of series "A." As

with the latter, Nos. 95 and 74 arrowed extensively in November, and have in consequence since been cut down and thrown out of cultivation.

I have put forward the foregoing results, contradictory as they are, in order to show the absolute necessity for prolonged and careful investigation before a better cane than the Bourbon can be definitely pronounced. To this end the cultivation on experimental lines of the above seedlings and others, notably B. No. 147, has been initiated on four other of the other British Guiana estates of the New Colonial Company. To secure adequate acreage, these have been drawn down and their cultivation extended, and it is hoped that, in the course of two or three years a mass of practical experimental evidence will be available. In the meanwhile, it may be stated that there are many points, such as vitality shown in spring and resistance to extreme climatic conditions, which, quite apart from sweetness of juice or extent of growth, are in themselves powerful factors in favour of seedling canes. It remains, however, to be seen how far these qualities will remain permanent. The influence of environment on the characteristics of canes cannot be overstated, and, until its full effect has been developed by successive years of cultivation, it would be premature to give definite pronouncement on a question so important to the well-being of the cane sugar industry.

SUGAR CANE EXPERIMENTS IN LOUISIANA.

The following summary of the recently published "*Field and Laboratory results for ten years*" by Wm. C. Stubbs, Ph. D., Director of the Sugar Experiment Station, and State Chemist of Louisiana, has been prepared for these pages by Professor J. P. d'Albuquerque, M.A., Island Professor of Chemistry and Agricultural Science, Barbados.

This Bulletin contains a summary of the field experiments conducted during the past ten years at Audubon Park, Louisiana, the questions dealt with falling under the heads: Preparation of the soil and economic cultivation of the sugar cane, Value of seedling canes, Comparative results of continuous planting of different kinds of cane, different parts of the cane and sizes of cane, The composition of Louisiana sugar cane and the fertilisers required for its growth (*i.e.* manurial experiments.)

Preparation of the Soil and Economic Cultivation of the Cane.

Louisiana soils vary from loamy silts through silty clays to pure clays. They possess great capacity for holding water, good drainage is therefore of paramount importance.

Tile drainage recovers and opens to cultivation large areas occupied by open drains, offers no harbour to insects, and permits cross ploughing of the land in preparation. The experiments with tile drainage have shown a uniformly increased tonnage which it was hoped would more than make up for the heavy first cost, but it was unfortunately found that the tiles rapidly filled with silt and are consequently too short lived to be profitable.

A triennial rotation of cane, corn, and cow peas prevails generally in Louisiana: that is, in the first year are grown plant canes, in the second year ratoons, in the third year corn is planted early, laid by early and at lay-by cow peas are sown. The corn is gathered early, and the pea vines turned under in August or September. The latter, a leguminous crop, supply nitrogen by fixing it from the atmosphere; and by their deep roots and immense foliage pump up and evaporate water, bring up soluble plant food from great depths, and place the soil in a condition as regards moisture most favourable to nitrification. The pea vines are best turned under by the disc plough which, for such work has no equal, is managed by one hand and works three acres per day. The land is then thrown into beds or rows 5 to 7 feet wide with a two-horse plough; and the middles (*i.e.* long stretches of space between the cane rows) are broken out with double mould board ploughs, and the quarter drains opened. The ridges of the rows are opened with the double mould board plough and two continuous canes deposited in the furrow and covered with the disc cultivator; hoes follow to insure perfect covering.

Up to seven years ago the cultivation of the cane, that is the tillage of the soil between the rows during cane growth, including weeding and the moulding up of the rows of canes, was carried out by the disc cultivator and double mould board plough. But an experiment with the diamond cultivator showed such advantages that a general plan was adopted consisting of the repeated successive use of the disc cultivator and the middle or diamond cultivator until the canes are too far advanced to work between them further.

The economy and efficiency of the use of improved implements in the cultivation of cane has been clearly demonstrated by the following experiments:—

A plat of ground containing seventy-two small experiments was selected. The cane was planted and an excellent stand all over the plat was secured. Five different methods of cultivation were adopted and were begun as soon as a stand of cane was secured, before breaking out the middles.

1. The middles were split out with the two-horse plough and all subsequent cultivation performed with this implement.

2. The middles were split out with two-horse plough and

the subsequent cultivation done with a disc cultivator and two-horse plough.

3. The middles were split out with two-horse plough and all subsequent cultivation performed by disc and middle cultivators.

4. The middles split out with double mould board plough and after operations done with disc and double mould board plough.

5. No plough used at all. Middles split out with middle cultivator and after cultivation with disc and middle cultivators.

These experiments were begun in 1897 with plant cane, and continued in 1898 with first ratoon.

The following is the yield in tons per acre from the two years' plant and ratoon canes :—

No. 1—62·88 tons.
No. 4—69·61 tons: gain of 6·73 tons over No. 1.
No. 2—70·59 tons: gain of 7·71 tons over No. 1.
No. 3—73·72 tons: gain of 10·84 tons over No. 1.
No. 5—74·65 tons: gain of 11·67 tons over No. 1.

The true principles of agriculture require a deep and thorough pulverisation of the soil, proper fertilisation, and shallow but rapid cultivation. Cultivation is but the maintenance of the tilth of well prepared land With the disc cultivator much or little mould can be thrown to the canes ; the middle cultivator can be regulated to run deep or shallow, and its shovels arranged to have much or little ridge. By the use of these implements a minimum amount of roots are cut, moisture is conserved and microbic action encouraged. All plant food is prepared by microscopic organisms, which teem in fertile soils of excellent tilth. The tankage, the cotton seed meal, the stable manure, and all other kinds of fertilizers must be converted into soluble forms before they can become available to plants. All this is accomplished through these organisms, and it should be the aim of every planter to encourage their multiplication as rapidly as possible during the growing season. It is known that fine pulverisation of soil, aeration and moisture (not standing water) contribute to rapid multiplication. These microbes must have air, and hence abound chiefly in the upper layers of the soil. When soils are deeply inverted by the plough, they are killed in large numbers. When soils are cloddy, their increase is necessarily checked, since moisture cannot circulate freely through them.

These are facts easily demonstrated, and in our experiments it was found that there were greater numbers of microbes in the finely pulverized soil of the cultivators than in the cloddy soils of the plough.

Again, the roots were less severely pruned and moisture better conserved with the cultivators—important factors during a prolonged drought.

The economy can be shown by stating that two cultivators cultivate, in five foot rows ten acres, in six foot rows twelve

acres, per day. In average seasons two pairs of good mules will cultivate eighty acres of land.

Seedlings.

Out of fifty varieties of seedling canes received from the West Indies and tested, only three have proved worthy of cultivation in Louisiana, viz: (Demerara seedlings?) Nos. "64," "74," and "95." No. 74 is pre-eminently attractive, giving a heavy tonnage, high extraction, and large sugar contents. In 1899 it gave 38 tons per acre of canes, yielding 81 per cent. extraction without saturation, upon our nine roller mill, and its juice contained about 16 per cent. of sugar. In 1898 and 1899 over two hundred bundles were sent out each year to planters.

Which is the best Cane for seed: Plant, or first or second Ratoon?

Two varieties, viz., purple and striped, were experimented with and this bulletin gives the results from 1891 to 1899.

These two varieties do not show the same relative results in regard to tonnage of cane or sucrose contents. Taking however the average of the two varieties, the plats grown with first ratoon seed cane gave ¾ of a ton more cane per acre than the plats from second ratoon seed cane, and 1½ tons more cane per acre than plats grown from plant seed cane. The order of the plats in sucrose contents is, however, as follows:—plats grown from plant cane, plats grown from first ratooon, plats grown from second ratoon.

"How far these differences are due to local environments, and not inherent in the cane, it is difficult to answer." The writer concludes as follows:—"The above is an average of many experiments extending over six years, and while not positive in its conclusions it is reasonable, we think, to draw the inference that good stubble [ratoon] cane is fully the equal, if not the superior, of plant cane for seed."

What part of the cane shall we use for seed?

Careful experiments begun in the last decade, have been made by planting "butts" (the lower third), "middles" (the middle third) and "tops" (the upper third) in separate plats of purple and striped canes. Continuous plantings every year have been made, using "tops from tops," "middles from middles," and "butts from butts," and the cane harvested in 1899 was the thirteenth in descent from "tops," "middles," and "butts."

The results given are the aggregate of fourteen field experiments, covering six of plant, five of first ratoon, and three of second ratoon.

The average of the two varieties of cane from each "tops" "middles," and "butts" are so nearly identical as to dispel any pre-conceived prejudice or preference for any portion of the stalk as seed.

The effect of continuous planting of different sizes of canes.

In 1894 the largest stalks that could be selected from the gen-

eral plat were used to plant a plat. Stalks of medium size and of the smallest dimensions were also simultaneously selected, and each planted separately in adjoining plats. From these three plats were selected, the next year, the "largest" stalks "from the "largest" plat, "medium" sized stalks from the "medium" plat, and the "smallest" canes obtainable from the "smallest" plat, and each planted again on adjoining plats. This has been repeated six times since, and each planting carried into first and second year stubbles. Thus, fourteen results have been obtained up to date, and Table III gives the average of these, and shows that while the plats planted continuously from large cane gave an average of 30·30 tons of cane per acre, the plats planted continuously from small cane gave only 25·95 tons of cane per acre, the richness of the juice being in each case about the same.

COMPOSITION OF LOUISIANA SUGAR CANE.

The results of Mr. Robert Glenk's researches upon the composition of Louisiana sugar cane are given as follows :—

To every ton of clean stalks of purple cane there were found 135 pounds of roots, 844 pounds of leaves, and 532 pounds of tops, or a total of 1,511 pounds, making, with the 2,000 pounds of stalks a total of 3,511 pounds.

A ton of striped cane has accompanying it 113 pounds of roots, 656 pounds of leaves, and 385 pounds of tops, or a total 1,154 pounds, making with 2,000 pounds of stalks, a total of 3,154 pounds. In cases where the roots, stubble, leaves and tops are left on the ground and incorporated with the soil the following extract from Table VII will show the mineral ingredients removed by a ton of canes, and also the amounts returned to the ground by the roots, leaves and tops.

MINERAL SUBSTANCES REMOVED, PER TON OF CANE, AND RETURNED TO THE GROUND BY THE ROOTS, LEAVES AND TOPS, WHEN TRASH IS NOT BURNED—EXPRESSED IN POUNDS.

Purple Cane.

	Nitrogen	Phosphoric Acid.	Potash.	Lime.	Mineral Matter.
Total removed by crop ...	2·98	1·63	2·52	2·54	44·63
Amount removed by stalks	1·08	1·04	1·22	0·52	11·18
Amount returned to soil	1·90	0·59	1·30	2·02	33·45

Striped Cane.

	Nitrogen.	Phosphoric Acid.	Potash.	Lime.	Mineral Matter.
Total removed by crop ...	2·38	2·07	4·18	2·03	41·59
Amount removed by stalks...	0·88	1·30	2·34	0·58	12·40
Amount returned to soil ...	1·50	0·77	1·84	1·15	29·19

A ton of purple cane as grown in Louisiana, with its accompanying trash burnt in the field, will thus remove 2·98 pounds of nitrogen, 1·04 pounds of phosphoric acid, 1·22 pounds of potash and ·52 pounds of lime. A ton of striped cane under similar conditions will remove 2·38 pounds of nitrogen, 1·30 pounds of phosphoric acid, 2·34 pounds of potash and ·58 pounds of lime.

From these data the losses occasioned the soil by the removal of a given number of tons of cane annually can be easily calculated.

FERTILIZING REQUIREMENTS OF SUGAR CANE.

Went, of the Experiment Station of Java, has shown, by growing sugar cane in water that, with the absence of either iron, magnesia, lime, phosphoric acid, potash or nitrogen, the plant soon died, showing the necessity of all these ingredients for growth.

He found that if one or more of these same ingredients were present in insufficient quantities, the plants grew very slowly compared with those which were abundantly supplied. The deficiency of nitrogen was soon apparent, while the absence of magnesia did not affect the plants for a long time. In the absence of iron the leaves remained yellow and became singularly curled, and the roots were very thin. On supplying this ingredient the green colour soon appeared, and the roots assumed their normal size and vigour. In the absence of nitrogen the leaves remained pale and narrow and the roots failed to develop.

It will thus be seen that sugar cane, like other plants which have been tested, must have the above ingredients in sufficient quantities to produce healthy vigorous plants.

In what quantities should these ingredients be supplied? How far do our cane soils furnish them in ample quantities for the growth of maximum crops? It is well known that all soils furnish iron in great abundance for all crops. It is believed that most soils furnish enough soluble silica, magnesia, lime and sulphuric acid to meet the requirements of all crops.

Should the last two be deficient, they will be incidentally supplied by the use of acid phosphate. Lime is frequently applied to soils not to supply plant food directly, but to react upon insoluble plant food, rendering it soluble, also to correct acidity, to humify and nitrify the organic matter, to flocculate heavy clays, to bind loose sands, &c.

The writer summarises the different sources of nitrogen, phosphoric acid and potash as fertilizers, and proceeds to describe the actual field experiments in Louisiana from 1890 to 1899.

In Dr. Stubbs' treatise on the sugar cane he gives the following analyses of the soils at the Sugar Experiment Station, Louisiana :—

	Insoluble Matter.	Potash.	Soda.	Lime.	Magnesia.	Iron Oxide.	Phosphoric Acid.	Sulphuric Acid.	Organic Matter.	Nitrogen.
Dark Soil...	62·550	·747	·181	·910	1·361	13·444	·146	...	6·65	·085
Light Soil...	70·102	·414	·021	·787	·814	11·28	·161	·019	3·16	·112

These soils are therefore comparatively poor in nitrogen and phosphoric acid but rich in potash.

Nitrogen Experiments. The nitrogen plats were begun with plant cane in 1890 and from 1890 to 1899 there have been eight crops of canes (plant or ratoon), one of corn in 1894 (unmanured) and two of peas 1894 and 1899 (unmanured). The sources of nitrogen in different plats were cotton seed meal, dried blood, sulphate of ammonia, nitrate of soda, tankage and fish scrap. There were certain plats that received each form of nitrogen alone, and others which received "mixed minerals" (72 pounds of soluble phosphoric acid and 50 pounds of potash per acre) with and without nitrogen in each form.

Owing to the fact that the soil employed was fresh and had been uncultivated for years, it was so responsive to cultivation that for the first two or three years no fertilisers gave decided results. Only during the last half of the decade has the effect of fertilisers been apparent, this has also naturally affected the answer to the question as to what quantity of nitrogen to apply. The early results favour one ration of 24 ℔s per acre the later results favour two rations.

An inspection of the table will show decided gains in favour of certain fertilisers. Let us compare the average results.

		TONS.
The average of the two unfertilised experiments is	...	26·34
The average of the nitrogen (alone) experiments is	..	28·26
The average of mixed minerals is	..	28·27

The average of mixed minerals and 1 ration of ni-

	TONS.
trogen is...	30·25
The average of mixed minerals and 2 rations of nitrogen is..	30·55
The average of mixed minerals and 2 rations of nitrogen (excluding tankage and fish scrap) is ...	30·93

It is therefore apparent that nitrogen does increase the tonnage and gives the best results when combined with minerals.

What quantity of nitrogen per acre gives the best results?

	TONS.
The average of one ration with mixed minerals is ...	30·25
The average of two rations with mixed minerals (excluding tankage and fish scrap) is...	30·93
Same with tankage and fish scrap is	30.55

Thus the two rations of nitrogen with mixed minerals give the largest results, but not enough to justify the extra expense of the additional ration. This is more apparent than real, since nearly all of the increase due to fertilisers has been made in the last few years, and each year the increased nitrogen fertiliser is producing more marked results.

What form of nitrogen is best suited for cane can be answered by comparing the different forms used alone and in combination (1 and 2 rations) with mixed minerals.

	TONS.
The average of 2 experiments with cotton seed meal is	58·82
The average of 2 experiments with dried blood is ..	59·56
The average of 2 experiments with sulphate of ammonia is	62·08
The average of 2 experiments with nitrate of soda is	57·30
The average of 2 experiments with tankage is ...	56.37
The average of 2 experiments with fish scrap is ...	58·64

From the above, which represents the calculated aggregate of two experiments with each, it will be seen that sulphate of ammonia is the best form of nitrogen for sugar cane.

Phosphoric Acid Experiments:—The phosphoric acid experiments occupied 19 plats, and there were grown on them eight crops of cane (plant or ratoon) two crops of corn and cow peas. Only the cane crops were manured. By "Basal mixture" is meant an application per acre of 48 pounds nitrogen as sulphate of ammonia and 50 pounds potash as sulphate of potash.

In the use of phosphatic fertilisers, 250 and 500 pounds of dissolved bone black and acid phosphates, each containing about 15 per cent. available phosphoric acid, have been used, representing 36 and 72 pounds of phosphoric acid per acre. With the other forms of phosphates, an equal quantity of each, 500 pounds, has been used, regardless of the percentage of phosphoric acid present. This was done with a view to determine the comparative values of these fertilisers (1) with themselves, and (2) with the soluble forms. The bones used contained a small quantity of nitrogen.

Arranging the results so as to obtain replies to the questions propounded to this plat, we have:

	TONS.
The average of unfertilised experiments	25·24
The average of basal mixtures	28·34
The average of soluble phosphates alone	28·00
The average of insoluble phosphates alone	27·10
The average of soluble phosphates, 1 ration and basal mixture	29·23
The average of soluble phosphates, 2 rations and basal mixture	29·84
The average of insoluble phosphates, 2 rations and basal mixture	28·66

It is evident from the above that phosphates alone have increased the tonnage, and when combined with basal mixture have given the largest results. A further comparison of the one ration with the two rations (both combined with basal mixture) shows very little gain for the latter. Indeed, not more than will frequently occur between adjoining plats fertilised just alike. It may almost be positively asserted that one ration of phosphoric acid, 36 pounds per acre, in an available form, is an abundant quantity of this ingredient in any fertiliser for cane.

What form of phosphoric acid is best adapted for cane, comparing the soluble and insoluble forms, is answered most positively in favour of the former, but when the individual forms are compared, it would seem that both slag meal and floats, (finely ground mineral phosphate) applied continuously on the same soil for many years, would ultimately furnish abundantly all the phosphoric acid needed by cane. Each year then, its efficacy becomes more and more apparent. Similar but diminished results are visible in the continued use of the other insoluble forms. Here is the comparison:—

Average of the dissolved bone black (alone) experiments	29·88 tons.
Average of the acid phosphates (alone) experiments	26·12 tons.
Average of dissolved bone black (1 and 2 rations) with basal mixture experiments	29·52 tons.
Average of acid phosphate (1 and 2 rations) with basal mixture experiments	29·55 tons.
Average of bone black alone	27·26 tons.
Average of slag meal alone	27·68 tons.
Average of floats alone	26·76 tons.
Average of ground bones alone	26·73 tons.
Average of bone black and basal mixture	27·59 tons.
Average of slag meal and basal mixture	30·44 tons.
Average of floats and basal mixture	29·19 tons.
Average of ground bones and basal mixture ...	27·44 tons.

These experiments show that small quantities of phosphoric acid have been beneficial to tonnage. How much of this action is direct and how much indirect, is as yet undeterminable. If a similar calculation be made on this plat as was done on plat V. A, it would show that even the one ration of phosphoric acid (36 pounds per acre) was an abundance for the wants of the crops.

It may be asserted, therefore, that our soils need phosphoric acid to grow cane, but limited quantities (from 200 to 300 pounds acid phosphate per acre) will suffice for good average crops.

Potash Experiments. There were nineteen experiments in this series, and, as would be expected from the richness of the station soils in this constituent of plant food, it is concluded from the results obtained that potash is not required in these soils to grow the maximum cane crop.

No attention has been paid to the sugar content in tabulating the results of the experiments just discussed, because, regardless of fertilisers there has been a slight increase in sugar content on all of these plats, as the experiments extended westward from the canal, due to slight but gradual change in the character of the soil.

Whatever differences may occur between adjoining plats are assignable to differences in tonnage rather than to the effect of the fertiliser *per se* upon sugar content.

The experiments of this station and a close observation throughout the State, confirm the opinions and experiences of other experimenters with sugar cane, viz, that there are no known fertilisers which will increase the sugar content.

It is known that excessive quantities of nitrogenous fertilisers reduce the percentage of sugar and lower the purity coefficient, since they produce canes more immature than others less bountifully supplied with this ingredient. For Louisiana the writer recommends that all nitrogenous manures be applied early in the growth of the cane.

In view of the fact that soils suffer loss in nitrogenous manures from leaching, an attempt was made to ascertain whether the canes would be benefitted by the supply of nitrogen being split up into two or more applications. The results were not conclusive, but point in favour of more than one application.

In the course of the report upon the nitrogen experiments the author makes a careful estimate of the losses and gains to the soil in nitrogen, phosphoric acid and potash and humus. In this soil account the losses are credited by the cane crops, and corn removed; the gains are debited to fertilisers applied, stubble of the corn crop (humus), and cow-pea crop (nitrogen, 100 pounds per acre fixed from the atmosphere; and mineral substances brought up from deeper parts of the soil, which though not a gain to the soil as a whole are a gain to its upper layers). By balancing the credit and debit side of this account an estimate may be made under any given system of cultivation of the net gain or loss to the soil in regard to any constituent of plant food. In the West Indies, account would have to be taken of the losses occurring from the wash of heavy rainfalls.

Filter Press Cake. Each ton of cane worked in a sugar house will give about 25 pounds filter press cake. Therefore, 40 tons will give 1,000 pounds, containing about 7 pounds of nitrogen and 5 pounds of phosphoric acid. If this be carefully returned to the soil, it will restore the nitrogen contained in

100 pounds cotton seed meal. Average filter-press cake is worth, according to the tariff of prices prevailing for commercial fertilisers, $1.75 to $2.00 per ton.

THE FIXATION OF ATMOSPHERIC NITROGEN BY LEGUMINOUS PLANTS.

The following summary of an article which appeared in the *Experimental Station Record*, 1893-94, pp. 749 854, from the pen of Professor H. Hellriegel, has been prepared for these pages by Mr. Albert Howard, B.A., Lecturer in Agriculture at Barbados. It affords a clear and useful account of the verification of the important discovery made at the Bernberg Station, that the nodules or tubercles on the roots of leguminous plants are inhabited by microscopic organisms, which have the power of fixing the free nitrogen of the air, and of thus enriching the soil :—

As an example of the inevitable reaction of practice on science the fixation of atmospheric nitrogen by the *Leguminosae* is one of the most striking. The fact that the fertility of arable land was greatly enhanced by the occasional growing of some leguminous crop for example, beans, peas or clover, between two successive cereal crops was known early in the history of agricultural practice. As time went on the system of fallowing was largely given up in favour of the practice of growing some leguminous crop instead, when it was found that even after that crop was removed the land was actually richer in nitrogenous matter than before. But it was not till the present century was nearing its end that a scientific explanation of the part played by the leguminous crop was given to the world. It might be argued that in this case practice was ahead of science, and that the practical agriculturist had recognised and taken advantage of a principle of which science had not offered any reasonable explanation, but which nevertheless was essential to any rational system of agriculture. But the argument is unsound. Methods based on mere empiricism must always give place to those built up on a solid scientific basis. Hellriegel's discovery of the part played by micro-organisms in the fixation of atmospheric nitrogen, which, in 1886 took the scientific world by storm, stands out as one of the greatest scientific achievements of the century. It was one of the most important discoveries in plant physiology, and certainly the most important one for agricultural science. It supplied a scientific explanation of a practice which had before been based on empiricism, and, at the same time gave to the world a method for the investigation of plant growth, that in the future is bound to bring in a rich harvest.

In the following, an attempt is made, to give some account of the method by means of which Hellriegel solved the nitrogen question, and of the experiment station where the work was actually carried out.

Hermann Hellriegel was born on October 21st, 1831, in Saxony, and after his scientific education, was in 1856 appointed to the direction of the Agricultural Station at Dahme then recently founded for the study of vegetable physiology. Here he developed upon a scientific basis the method of sand, culture identified with his name, viz., the growth of plants in pure sand, as far as possible free from all plant food, and adding thereto the various food materials in known amounts: light, water, heat etc. being so regulated that all the factors of plant growth were kept under exact control. In 1881 the Government of Anhalt with the co-operation of the Association of German beet sugar growers founded an experiment station at Bernberg and Hellriegel was appointed its first director. Here he laboured till his death on September 24th, 1895. His work is a model of patient scientific thoroughness.

The Bernberg Station. The recognition of the fact that the essential conditions of plant-growth cannot be investigated by field experiments alone, led the Association of sugar beet growers in Germany, to found an experiment station, where such problems could be investigated by scientific methods of research. Such a station was founded at Bernberg and began its work on April 1st, 1881, its object being the study of the laws of growth and nutrition of the most important agricultural plants and especially the sugar beet. It was deemed necessary to conduct the experiments in pots so that the growth of the plant and every thing pertaining to it might be closely watched. For the result to be of value it was necessary that the artificially grown plants should develop in the normal manner and that the results should be the direct consequence of a given set of experimental conditions. For this purpose it was necessary to have a suitable place and the necessary equipment for the growing of plants, together with a chemical laboratory. The Bernberg station has both, and in addition, an experiment field where the results of the investigations in the laboratory may be put to a practical test.

The station is under the immediate control of the Ducal Government of Anhalt. Its management and the selection of lines of investigation are placed in the hands of a Board appointed for that purpose.

The entire station with its appliances and apparatus cost 30,000 dollars. In the year 1892-93 the subsidy of the station amounted to $6,250 of which $3,500 was supplied by the Government and $2,750 by associations and societies. The chemical laboratory measures 165 × 37 feet and there are in addition ten rooms for special purposes. The total space devoted to the experiments is divided into three principal parts, namely, the garden, the greenhouse and a shed used to protect the plants from the sun, rain and hail. There is also a preparation room (68 × 43 feet) where the apparatus used in the pot cultures is kept and where the materials are sterilised. The various parts of the station are

connected by car tracks, 40 inches in width, which facilitate the movement to and fro of the wagons which carry the pots containing the plants under experiment. The wagons, which are kept in the greenhouse over night, are rolled out at 6 *a.m.* and remain in the open air till late in the evening unless winds or unusual heat make it desirable to move them to the cover of the greenhouse or shed. Since rain falls very often, and, under certain conditions, a single severe rainfall may render the results of an experiment worthless, constant watch has to be kept over the plants. As soon as rain threatens, the wagons are removed into the greenhouse. Since rains may continue for a week at a time, special pains had to be taken in the construction of the greenhouse in order that plants might remain in it for such periods without injurious affects. Hence the iron framing was made as slender as possible to avoid shading the plants. The dimensions of the greenhouse are 85 x 23 feet. Attached to the greenhouse is a photographic room, so equipped that photographs of the plants can be taken at different times. During hailstorms and when the heat is so excessive that the plants are in danger of injury, the wagons are brought under the shed which is open at the sides and ends. The plants are watered in a special room attached to the shed, each pot being weighed before watering, the amount of water added in each case being measured.

The pots used in the experiments are of three sizes, depending on the root developement of the plants under investigation. The pots are of glass and are covered on the outside with a layer of black and then with a layer of white paint. The pots are arranged in the wagons so as to avoid too much exposure to the sun's rays and at the same time to prevent the plants from shading one another. To prevent the depredations of birds, the wagons are covered to a height of 5 feet with netting.

Pure quartz sand is used for soil material. Except in experiments with sugar beets, in which the pots have to be so deep as to require the addition of some material to increase the water holding capacity of the sand, no extraneous soil material is added.

The station prepares its own distilled water, using a copper still and condenser. This water is tested very frequently and must be free from compounds of nitrogen. The necessary fertilising materials required for the growth of the plants are given in the form of solutions where possible.

Only the best quality seed is used. Each seed is accurately weighed and only those seeds are selected whose weights vary very little from the average weight of a seed of the plant in question. In this way uniformity in the size of seed and consequently equal amounts of reserve food are secured.

The selected grains are soaked in distilled water for 24 hours and then allowed to germinate upon moist sand, and only those are used in a series of experiments which show as nearly as possible the same germinative energy. Twice as many germinating seeds are planted as the number of plants required.

Since almost every plant has its own special requirements as regards moisture and combinations of nutritive solutions,

these conditions must be first worked out so that normally developing plants may be obtained. The size of pot, the amount of water and food material best suited to each individual species have to be determined. Leguminous plants thrive best when no nitrogen, or at least a very small quantity, is supplied. Care must be taken, however, not only to have bacteria present in the soil, but also to have just the kinds needed by the particular kind of legumes. The sand should be inoculated either with soil infusion or with a pure culture of the bacterium appropriate to the plant.

Sugar beets are grown in pots 31 inches deep. Pure sand cannot be used in these experiments since water cannot be distributed evenly through so high a column of that material. The water-holding power of the sand is increased by adding 6 per cent. of pure peat from which the soluble plant food has been extracted with hydrochloric acid. Special precautions are necessary to keep the mixture of sand and peat uniformly moistened.

As soon as the young plantlets have been placed in the culture pots they must be carefully shielded from injury and especially from frosts at night. Half of the seedlings are removed and these are analysed to determine whether they have withdrawn any plant food from the soil medium, and if so, how much.

In regulating the water supply natural conditions of growth are imitated as closely as possible. In the watering of each pot the amount of water lost by evaporation is determined by weighing and is replaced by a measured quantity of distilled water.

In order to protect plants which grow to a considerable height (as peas, barley, oats, etc.) from damage by wind, supports are necessary. The plants must be carefully kept free from worms, and all leaves that fail off during the period of vegetation are collected, dried and weighed and their weight added to the crop at the close of the experiment. Notes on the condition of the plants are made at short intervals during the summer, and thus a record of their growth is obtained. All plants which show any interesting peculiarities are photographed.

In harvesting, the parts of the plants above and beneath the soil must be collected. The correct answers to all the questions which have been raised in the experiments are to be found by analysing, not the whole plant together, but the various parts, stems, leaves, seed, chaff and roots, separately. In this way alone is it possible to find out by means of chemical analysis which of the different nutritive materials are of special use in building up this or that part of the plant: in what form the plant food may be supplied with the greatest advantage and, if the plants are harvested at different stages of development, at what period of growth the plant takes up the main part of its food.

It now remains to indicate shortly the methods of sterilised sand culture employed at the Bernberg station by means of which Hellriegel discovered the relation between micro-organisms and the acquisition of atmospheric nitrogen by plants.

Certain micro-organisms are essential to the processes of leguminous plants, and especially to their acquisition of nitrogen. If these organisms are excluded, for example when the legumes are grown in pure sand which contains no organisms, and none are introduced during growth, the *Leguminosae* behave in exactly the same way as the grasses. Under these circumstances they do not acquire nitrogen from the atmosphere, and their development is proportional to the quantity of nitrogen supplied them in the soil. When peas, etc., are grown in sand containing no nitrogen and deprived of these organisms the development of the plant proceeds until the nitrogen of the seed is exhausted. Then growth is checked, a starvation period sets in and the plant usually dies before flowering.

Such a plant contains almost exactly the same quantity of nitrogen as was originally present in the seed from which it grew. If a nitrate, for example calcium nitrate, is added, the growth of the legume continues and an amount of plant substance proportionate to the supply of nitrogen is produced. But the behaviour of the legumes undergoes a marked change if certain micro-organisms are added to the soil. Under these circumstances the legumes thrive in sand free from nitrogen compounds and produce a normal yield. The entire amount of nitrogen required by the plant is supplied by the atmosphere. The roots of these plants are found to be covered with small knotty protuberances known as root tubercles. The roots of plants from which micro-organisms have been excluded are found to be free from tubercles. Hence Hellriegel concluded that the root tubercles and the acquisition of atmospheric nitrogen by the legumes stood in the relation of cause and effect.

These tubercles are caused by certain bacteria, chiefly by *Rhizobium leguminosarum*. These bacteria penetrate through the root hairs into the cortex of the roots and there give rise to the tubercular growths. Microscopic examination of these tubercles shows them to be filled with a bacterial mass composed principally of abnormally developed bacteroids, but in part also of bacteria which have remained in their normal condition. The former are consumed by the host plant, the latter remain in the soil to provide for future reproduction. We have here an example of a life-partnership (symbiosis) in which the *Leguminosae* furnish carbo-hydrates to the bacteria which in turn possess the power of taking up free nitrogen and passing it on to the plant in an available form. So close has the bacterium adapted itself to its particular host that, for example, the organism peculiar to pea-tubercles will not produce tubercles on the roots of lupins and *vice versâ*. Again, the external form of the tubercle remains fairly constant and is generally speaking a well-marked generic character. It would be an interesting biological problem to find out by cultivation if the bacteria of, for example, the pea-tubercle could not be made to infect other genera of leguminous plants. Gelatine cultures of the bacteria of the various economic legumes have recently been put on the market under the name of "Nitragin."

In experiments on nutrition with nitrogen, all sources of this element not under control, as well as all bacteria which

produce root tubercles, must be excluded. Since they are abundant in every cultivated soil they occur everywhere in dust. The sand used in the experiments, the nutritive solutions and all apparatus used in filling the pots, are sterilized by heating to a temperature of 150° C. The seeds used are sterilized in corrosive sublimate solution, after which they are washed with sterilized water and placed in the germinating mediums. After planting, the pots must be covered in such a way as to exclude bacteria. This is done by means of a layer of dry peat which is placed over the culture sand and the pot is covered with a fine cloth or gauze, holes being made for the watering tube and the plants. The pots are watered with sterilized water, the requisite amount being determined by weighing the pot.

When the legumes are grown in sand free from nitrogen, but containing the other soil ingredients of plant food, and when bacteria are excluded, the plants which are developed at the expense of the nitrogen of the seed are small and half-starved and when the supply is exhausted they gradually die. When, on the other hand, the requisite bacteria are added, development proceeds as before at the expense of the nitrogen of the seed. The plants then remain in the starvation stage for some time, during which time tubercles are forming on the roots. When the tubercles are developed the plant suddenly becomes green, and the growth luxuriant, as ordinarily comes with abundant supply of nitrogenous manure.

Mixed cultures of legumes, and plants of other natural orders were next grown in the same pot to determine the effect of the same kind of bacterium on the different plants. No nitrogen was available except that contained in the seeds. The non-leguminous plants died of starvation in all cases, while the leguminous plants developed nodules and grew luxuriantly. When the soil extract containing the bacteria was previously heated to 70° C. no tubercles were developed, thus confirming the conclusion that micro-organisms are the cause of the root tubercles of the legumes.

Such in brief is the Bernberg experiment station and its methods. The thoroughness of the equipment and the methods of investigation, the close and sympathetic co-operation between the scientific workers and the men engaged in practical agriculture, and the readiness on the part of the Government and the sugar beet growers to provide for such a station, stand out in striking contrast to the general attitude of the English people towards scientific investigation, and show clearly the causes which have led to the success of the German sugar beet industry.

TREE PLANTING IN ANTIGUA.

BY THE HON'BLE FRANCIS WATTS, F.I.C., F.C.S.

Government Analytical and Agricultural Chemist to the Leeward Islands.

A country covered with timber presents a marked contrast in many ways to a country where trees are scarce and it is generally recognised that tree-covered areas exert a considerable influence on the climate of the immediate neighbourhood. The subject has been closely studied in many countries and efforts have been made to ascertain precisely what these effects are and to measure their extent.

Within a forest or high wood the temperature is cooler, owing to the leafy screen intercepting the rays of the sun and producing a grateful shade, but the difference in temperature goes beyond this, for careful observations show that in hot weather, in summer in temperate climates and all the year round in the tropics, the temperature in this shade is lower than the temperature in a shady spot remote from the forest influences, thus indicating that the effect on temperature is more than the effect of mere shade. In hot weather this difference may amount to 8 or 10 degrees Fahrenheit. On the other hand it is interesting to note in passing, though the fact has but little practical interest for us in the West Indies, that a forest serves as a protection against the extreme severity of winter cold, the temperature within the forest being several degrees higher than without.

In the same way that the temperature of the air is affected so is the temperature of the soil; the soil is thus protected from the extreme variations met with in the open country.

A forest or wooded area thus renders more equable the climate within its shade and this effect is communicated to some distance beyond the limits of the trees themselves. This effect is the more marked and valuable in countries where temperature tends to extremes, so that we dwellers in the tropics may expect to witness this influence in a marked degree.

But not only is the temperature influenced, the moisture is affected also, the air of the forest being relatively moister than that of the open country. It has been questioned whether the absolute amount of moisture in the air is greater within the forest and observations made in Bavaria rather tend to indicate that it is not. I infer, however, that under the conditions prevailing in the tropics the absolute as well as the relative amount of moisture will be increased.

The question of the effect of forests on rainfall has been much debated, and, as summing up the position, I cannot do better than quote from Dr. Schlich's "Manual of Forestry," Vol. I. page 40. "The question whether, and in how far, forests affect rainfall, is one which has been actively discussed for many years past, but so far no final decision has been possible. That forests can affect precipitations follows from the facts that the forest air is relatively moister than air in the open, and that trees

mechanically affect the movement of the air; but, on the other hand, the rainfall depends chiefly on other much more powerful agencies, in comparison with which the effect of forest is small. Numerous comparative observations have been made, but only a certain portion has so far been published, and unfortunately those which seem to indicate a decided effect of forests on rainfall are not always very reliable. The great difficulty in comparing the results of observations at forest stations (that is to say, stations situated inside a forest) with those of the ordinary meterological stations, consists in the fact, that elevation above the sea affects the rainfall most powerfully, because air cools on rising and precipitations become frequent with elevation." On page 42 he writes: "On the whole it may be said, that various physical factors act towards rendering forests excellent condensators of vapour, because they have a lower temperature, a moister air, and break the force of air currents. These powerful properties are more evident in elevated positions than in lowlands and in the vicinity of the sea, where they are swamped by other more powerful agencies. Absolute certainty in respect of these phenomena can only be obtained through further extensive observations."

Even with the uncertainty as to the effect of forests in general on rainfall I think we are safe in concluding that, under the conditions prevailing here, an increase of timber in large clumps or masses and of such a quality as to produce a fair amount of shade, would have a marked effect upon the moisture of the air and that we should see these woods acting as "condensators of vapour" as Dr. Schlich phrases it, thus performing a duty which we greatly need. During hot dry weather we frequently observe light showers begin over the sea to windward of the island; as these showers approach the shore they become lighter, frequently ceasing as they pass over the heated land: now it seems more than probable that a well-timbered area, owing to its being cooler than untimbered land, would lead to condensation taking place, and a cool shower taking place precisely at a time when showers are most urgently needed. On the whole we may expect that an increase of trees would lead, directly or indirectly, to an increase of moisture.

But not only is the amount of moisture falling as rain to be considered, the influence of the forest or woodland is far more marked in its effect on the distribution of the water after it has fallen; in the first place the evaporation is diminished so that the soil remains moister, but another and greater effect is observed; most of the rain falling upon a bare slope or upon a pasture rushes rapidly into the drains and water-courses, comparatively little soaking into the soil if the fall is very heavy; after the first inch or so has fallen the amount soaking in steadily diminishes, so that a point is reached when practically all that falls subsequently runs away without benefiting the soil, indeed on the contrary, often damaging it by washing away the surface mould. But when rain falls upon a tree-covered area its force is broken, it meets with various obstacles retarding its rapid rush over the surface of the ground, while the surface of the ground acts as a huge sponge, retaining much of the water, from the presence of a covering layer of dead leaves and small

undergrowth. The layer of leaf-mould found in some woods is capable of holding water equal to a rainfall of upwards of five inches. It is this feature of wooded districts which leads to the existence of streams in wooded valleys, these streams as a rule do not flow from springs in the ordinary sense of the word, but are fed from the water retained by the covering of leaves and small undergrowth. We have an instance of this in the streams at Fig Tree Hill and Christian Valley. If once the trees in these neighbourhoods were cleared these streams would quickly disappear. Conversely we may picture to ourselves what the condition of the island would be were the hills adequately clothed with timber, so that each valley had its perpetual stream; what a relief from our water famines this would constitute, to what increase of fertility would it lead and how beautiful would become many districts which are now little better than arid wastes.

Under existing circumstances many of our hills, instead of forming natural reservoirs of water, feeding the streams refreshing the land, now constitute sources of loss; the rain falling upon bare slopes, or upon slopes covered with but a scanty covering of grass, rushes away without hindrance, carrying with it any loose soil. There are formed temporary large and wild streams which do considerable damage and are productive of little good, sudden in their rise and equally sudden in their fall they are of little value as sources of water, though usually in the larger streams there are small ponds and water-holes filled with water of bad quality. Nearly every one of these streams marks the course of what, under favourable conditions, might be a constant wholesome rivulet.

By retarding the flow of water over the land, woods and forests preserve the soil from wasteful washes and prevent the formation of dangerous gullies. This danger from the formation of gullies is not so prominently brought to our notice in Antigua, where the soil on the slopes is of no great depth, while in the lower lands it is stiff and tenacious. In some countries large tracts of country are actually devastated by gullies, which often begin as unnoticed little washes in abandoned fields or in places where timber has been felled and the land left bare.

Belts of timber constitute valuable agencies in sheltering tracts of land from hot drying winds. In this island there are many places which suffer extremely from a small rainfall accentuated by high winds, which speedily cause the evaporation of the small amount of moisture in the soil. The difference between the amount of evaporation in a still atmosphere and in a breeze is enormous, no one knows better than a planter the drying effect of a high wind. If the tops of some of our low hills were covered with timber it is reasonable to suppose that the climate on the leeward side would be improved and the fertility of the soil perceptibly increased. In these islands, where the prevailing winds are constant in direction, more advantage may be expected from the sheltering action of masses of trees.

Some forms of wood, if properly cared for, might form welcome shelter for cattle, while producing a certain amount of grazing.

With an increase of timber an increase of birds may be expected.

While touching upon this aspect of the influence of woods, the question of the influence they may have upon two of our pests may be thought of: I refer to the mongoose and to ticks. I fear the former will find shelter, but I do not believe it will be more favourably sheltered by properly grown, shady woods than it is by the low scrubby bush now existing and which I think could be replaced to advantage by shade-giving trees; if this is so I do not think any disastrous increase of mongoose is to be feared; so far as I am aware, it is not the real forest areas which encourage mongoose but rather the low dry scrub, possibly the moisture of dense woods would not prove congenial. With regard to ticks, it would seem reasonable to suppose that they are encouraged quite as much by the thin scrub as they would be by well grown, shade-giving woods.

These are some of the effects of woods and forests, but there is a direct effect which should not be lost sight of, they should afford a source of income to the estate on which they are situated. I fear we are too disposed to regard trees as accidents of nature to think much of wood as a means of revenue in Antigua, but the idea is worth dwelling upon. After a wood reaches a certain age a fixed proportion of the trees may be cut annually, it is a crop to be harvested and the harvesting should be done systematically: after the cane crop is reaped comes a time when work for labourers is scarce, there is little to be done until the work of preparing the land for the next crop commences; this is a period in which the care of the woodlands would afford occupation for some of the best of the labourers. I may suggest a few ways in which a regularly grown and regularly harvested wood may provide useful material, both for the estate and for the community generally. Wood for building estate carts, not only wheels but all parts, may be obtained, so may posts and rails for fencing, while a regular supply of hard-wood for house construction would be a boon. One sometimes finds an old house in some country place, which has stood long and whose floors and roof have remained in spite of neglect; if any enquiry is made one is almost certain to learn that its timbers are of native hard-wood, and to hear it regretted that such is not procurable now. It might have been procurable if our predecessors had cared for our woods. Wood for staves of casks, barrels and hogsheads, wood for boat building, for furniture and for firewood, while if considerable quantities of wood are regularly cut and harvested the best pieces may be set apart and occasional shipments made. With a more abundant supply of wood and the selection of durable kinds, improvements should result in our houses and in our estates' buildings generally.

This aspect of the wood as a crop to be harvested is one I would commend to your attention; it is true that years must pass before such a condition can be arrived at; we are suffering from want of forethought on the part of those who went before us, but this cannot be regarded as a valid excuse for doing nothing to improve matters; it will require little expenditure in the way of effort and less in the way of money to start a

movement for re-stocking the waste places of the island with trees, which in a few years will be useful in ameliorating the climate, in conserving moisture and restoring our streams, in providing a revenue, which if not extensive will at least recoup any actual expenditure which may be made, while some additional labour will be provided for our work people of several classes.

Now it is well known that the sugar planter does not like trees, and from his point of view I am disposed to agree with him, for he is usually thinking of solitary or scattered trees near his cane fields: these are a source of trouble to him and are probably of little use. What we want are large clumps of trees, acre upon acre in size, if we can get them, then we can afford to get rid of some of the trees which our friends often tell us regretfully are much in their way; however, until we can be assured that a movement for re-afforesting our waste lands is established, and in actual, rapid progress, let us do our best to preserve every tree we can.

If we take a glance at the conditions prevailing in Antigua we shall find that the hills extending from about Blubber Valley to English Harbour have at one time or another, with very little exception, been denuded, they are now covered with thin timber and scrub with large open spaces of grass. The heaviest timber exists about Orange Valley, Christian Valley, and from Bott's mountain to the neighbourhood of Fig Tree Hill and Claremont. When we pass to the limestone hills running from Hope's Head through Parkham to Collins, Montpelier and Freetown, we find them covered for the most part with low scrub with few shade-giving trees, a few loblolly trees are to be seen, but no trees of any size, such as it is conceivable once existed, and should exist again. Then there are acres of lowland with here and there slight elevations, barren and treeless, covered with indifferent grass and affording but poor pasturage, in some cases this is covered with thin troublesome acacia scrub which affords little shade and few of the advantages which would follow from the presence of shade-giving trees. If those who are in charge of these lands are convinced that the establishment of trees on some of these areas is really desirable, then I believe the trees will be found there before many years are over. That is where the movement has to begin; if those who have the care of these places want trees they will secure them; if they do not want them, no amount of talk, discussion, legislation or Departments of Agriculture will succeed in putting them there. I therefore beg you, who are thus responsible, to give the matter your consideration and make up your minds whether we are to have trees or no.

If we are to have trees how are we to go to work? The process must be a gradual one for several reasons; we have no reserves of money to expend on the work, trees are of slow growth and public opinion is not very strong. The first step I think should be the establishment of leafy, shade-giving species on the lands which are now out of cultivation, attempting to establish clumps of trees on the places now overrun with acacia, planting these clumps on the little knolls and low elevations. Then efforts may be made to improve the

character of the timber on the limestone hills, by introducing amongst the existing trees and shrubs, better kinds of trees. When these trees are planted their growth at first will be slow, but as time goes on and they improve the conditions of their own neighbourhood, they will grow more rapidly and render it possible to grow better and better trees. Much may be done in places covered by low bush, as the limestone hills for the most part are, by planting seeds in the bush without disturbing the existing growth; this is a very inexpensive mode of proceeding, and one within the reach of anyone anxious to make an attempt to improve his woods. In this manner it is probable that such trees as mahogany, red cedar, locust, sandbox, mango, tamarind and many others may be introduced into suitable localities. In more exposed situations it will be best to plant the young trees themselves.

Most writers on the subject advocate close planting, and point out that a mistake is frequently made in planting trees for such purposes as we have in view, too widely apart, as if an attempt were being made to establish a fruit orchard. Wide planting permits the young trees to make a great development of lateral branches, so that short trunks, forking near the ground, result; at the same time the ground is imperfectly shaded and the growth of undesirable weeds permitted. In the United States it is suggested that 3 × 3 ft. or at the most 4 × 4 ft. is the best distance to plant young woods; this seems very close and it is a question whether in the tropics, where growth is rapid, these distances may not be somewhat increased, but wide planting should not be attempted. The trees may be thinned out as circumstances demand, but this thinning should not be done too early. Thinning gives the first crop from the wood-land and results in a useful supply of rails, posts, or other light timber together with a supply of firewood. On the edges of plantations the trees should be placed quite thickly as they thus afford mutual protection and shelter.

When planting it is desirable to plant several kinds of trees and not to plant a large area with one kind only; the various trees, having different habits and different rates of growth, result in a better covering and growth than if a single species were planted. If all the trees are of the same kind and of the same age, the leafy canopy is at a fairly uniform height from the ground, gradually rising year by year, but when trees of different kinds are planted their rates of growth being different it usually results that the crowns of the trees are at different heights, thus forming a better protection against wind. The feature of even height of crowns with absence of undergrowth is well seen in the many clumps of mahogany trees scattered over the island of Barbados.

We have in the island many kinds of trees which may be grown to advantage and which will thrive under different conditions. I may mention the names of a few which occur to me.

Mahogany	Mango	Lignum Vitae
White Wood	Locust	Walnut (*Andira*)
Tamarind	Sandbox	Casuarina

Bois Noir	Jamaica Shade Tree	Nim (*Melia sp.*)
Log-wood	Mammee Apple	Turpentine
Red Cedar	Calabash	Cabbage Palm
White Cedar	Breadfruit	

If a keen interest is taken in the subject it will be easy to secure the introduction of new and useful kinds from other countries. Efforts will be made on the part of the Botanic Station to secure supplies of seeds and young seedlings of all the more desirable kinds of trees for distribution, either gratuitously or at very low rates, to those who will assist in the work of systematic tree planting; but it must be remembered that this will be of little avail unless those who have the care of the land will assist in the work. I shall be glad to hear from those who are interested in the matter what their requirements are and what they propose doing, when I will use every effort to aid them as much as possible.

I was surprised, after my experience in these islands, to find how many and how durable are the hard-woods of Jamaica; a planter there has the chance of putting up posts of native woods with the assurance that they will last a reasonable time and will not be ravaged by wood-ants; I fancy that many an Antigua planter will envy Jamaica in this.

There is one point which I have left till last, because of its importance; I refer to the indiscriminate burning of pastures. If this continues as in the past the work of establishing trees will be rendered extremely difficult; these pasture fires, sweeping over the country destroy young seedling trees by hundreds, they injure and destroy those trees which may have succeeded in making a little growth, and, year by year undo all that nature is striving to do towards the clothing of our hill sides with desirable timber. Something must be done to check or to limit this.

Some of this burning of pastures is done deliberately and for definite reasons; most of it is the result of carelessness and thoughtlessness. Where the burning is done intentionally it usually has for its object the removal of the old coarse dry grass in order to produce a fresh growth upon which cattle will feed, or it is intended to destroy ticks. With regard to the custom of burning to produce a fresh growth of grass, I am strongly of opinion that the process is a destructive one in the long run. It seems to me that better results may be obtained in other ways. Burning certainly effects its purpose in removing the old grass, but it has other and disastrous results. In the first place it is extremely wasteful, destroying tons of vegetable matter which should be returned to the soil in order to increase its fertility; in countries where pasture lands are properly cared for they are found to be richer in humus and in nitrogen than the arable soils of the same neighbourhood, and this in the cases where heavy crops of hay are removed year after year; properly cared-for pastures should increase in fertility. Can we say this for our Antigua pastures? Our burned pastures (fortunately there are some pastures which escape this scourge of burning), have a poor dry soil, poor in humus and covered with hardy grass growing in tussocks, the better kinds of grass are killed out, the soil is made too poor to

nourish them, and the result is we go from bad to worse. This subject of the care of pasture lands is too important to be dealt with to-day and deserves special consideration and discussion: it would be well if at a later date this Society invited its members to express their views concerning it, I am compelled to introduce it here because of the disastrous effects upon seedling trees and young timber which these uncontrolled fires have, sweeping across the country and burning for days together ; but for this it seems probable that much of the island would be covered with heavier timber. I introduce it to condemn it, but I shall be glad to deal more fully with the question on a future occasion, if the Society desire it.

The question of burning pastures for the destruction of ticks opens up a wide field for discussion ; for my part I cannot help feeling that burning is too drastic and disastrous a mode of procedure and that better results may be secured by other methods.

This is by no means the first time that the question of the desirability of increasing our timbered areas has come under discussion in Antigua. The matter has been talked of over and over again, but I cannot learn that anything has been done or that any progress has been made. In 1888 a report on the subject was made by Mr. E. D. M. Hooper of the Indian Forestry Department; with his general conclusion I think we all agree; but, so far as I know, nothing has resulted. I attribute this want of action to the feeling, (not peculiar to forestry discussions) which possesses nearly every individual, that someone, the Government for preference, really ought to do something, but that he, personally, is not called upon to do anything; he signifies a generous approval of the general propositions, and there the matter ends. And there the matter will end for all time unless the individuals in the community feel that the problem is theirs, that they own, or have charge of, the land, and on them rests this responsibility of action. Government aid and assistance, legislative and otherwise, will follow fast enough if a strong public feeling exists on the subject: in most countries useful legislation has lagged behind public opinion, and so it is in this case.

In this particular matter it is not necessary that there should be much in the way of co-operation or combination, every individual who has care of any land can act for himself, he can scatter seeds of useful trees throughout existing bush and scrub, and he can plant young trees in desirable situations. Not much money is wanted, the main requirement is individual effort based upon a sense of individual responsibility.

CARE OF PASTURES IN ANTIGUA.

BY THE HON'BLE FRANCIS WATTS, F.I.C., F.C.S.

Government Analytical and Agricultural Chemist to the Leeward Islands.

There is so much of what is usually called "waste land" in Antigua, in spite of its small size, that there is a very common disposition to regard these lands as of no value for any purpose and as requiring no care. This is unfortunate, for it leads to the neglect of much land which should be of real value for two purposes, namely, pasture and wood-land. Perhaps it is partly as a consequence of this that our recognized pastures receive so little attention. Another cause lies doubtless in the fact that at certain times there is a superabundance of fodder, the fact that, at certain other times, there is a scarcity being overlooked. It remains to be decided whether means may not be found whereby these so called "waste lands" could be utilized and our pastures improved. This Society lately dealt with one aspect of the question in the discussions which took place on the subject of "Tree Planting." To-day we are to deal more particularly with the care of pastures.

Perhaps the first question which may arise is "why should we bestow any more care on our pastures than we do at present?" The answer would be, I think, that at present the majority of the pastures fail to provide as much food as they are capable of doing; that at times, as during drought, they afford practically none; that they do not provide the best and most remunerative kinds of fodder; that they are in some respects, and under some conditions, not the most suitable places for cattle to be kept upon; and that they admit of improvement in all these particulars.

This matter, the care of our pastures, has been brought to our notice at various times. On September 7th, 1894, Mr. Barber read a paper on Antigua grasses and a discussion on this followed on October 5th. At this meeting a resolution was passed asking the Society to form a Committee to take the opinions of pasture-owners and to report as to the desirability of asking for legislation on the subject of pasture fires. I cannot learn that anything has been done. The matter, therefore, again comes up for discussion.

Mr. Barber's paper described five of our well-known grasses: Guinea grass (*Panicum maximum*), Hay grass (*Andropogon caricosus*), Bahama grass (*Cynodon Dactylon*), Sour grass (*Andropogon saccharoides* vel *pertusus*) and Bed grass also known as Paramatta and Smut grass (*Sporobolus indicus*). He also made suggestions as to the care of pastures and their general management.

In the "*Kew Bulletin*" of November of the same year (1894), there is an interesting and important article on "Tropical Fodder Grasses." In this article, the principal kinds of tropical grasses are described, and some points respecting the general

care of pastures are alluded to. At the end of this article there is a short bibliography. Of the seven books there mentioned, three are in our small library, and are thus available for reference.

The subject before us divides itself into two branches: (1) the care and management of the pastures as regards grazing, cultivating, fencing and similar operations; and (2) the kinds of plants to be grown.

I will briefly state some ideas which have occurred to me, and I have no doubt that there are many present who can, from their practical acquaintance with the subject and their knowledge of local conditions, add materially to the discussion and help us to arrive at a clear understanding of our requirements.

One of the first things wanted would appear to be a better system of fencing. If the pastures are enclosed and grazed systematically they will carry much larger herds, and the character of the herbage will be improved: the finer and more nutritious grasses will have an opportunity of establishing themselves, while the coarser grasses will disappear. Suitable fencing is not expensive, particularly if posts which will grow are planted and wire run upon these. The Turpentine tree (*Bursera gumifera*) answers the purpose well. I noticed in Jamaica, a much larger and in places wilder country than this, that fencing is very general, and I am informed that the owner of land can compel his neighbour to contribute one-half the cost of fences separating their properties.

It appears very necessary that steps should be taken to discourage and prevent the indiscriminate burning of the pastures which now takes place. This burning is wasteful in many ways. It destroys the finer grasses and encourages the poorer and less useful ones. It impairs the fertility of the soil, for it destroys the vegetable matter which by its natural decay would, year by year, add greatly to the store of humus in the soil and lead to the formation of turf, a thing absent from these burned pastures. Again, the burning causes the entire loss of the nitrogen, that most costly constituent of the manures we use. If anyone wishes to see how important nitrogen is for his pastures let him throw a little nitrate of soda, or sulphate of ammonía, both purely nitrogenous manures, on a patch of grass which he can watch; it will not be long before the change in appearance will convince him of its powerful influence.

It is urged that this burning is necessary for two reasons, —to destroy ticks, and to produce a growth of grass which the stock will eat. As for the efficacy in the matter of the ticks I am somewhat doubtful, but this surely must be a matter on which those who have encouraged burning must have made some observations, with which I am sure they will favour us. As for the second object, that of obtaining grass which the animals will eat, it seems to me that this can be attained to greater advantage in other ways. Certain grasses are eaten readily when in a young state but are refused by animals when they are in flower. This is the case with the Bed grass (*Sporobolus*), and a grass very common on our roadside, *Chloris*

barbata, of which I do not know the common name. These grasses are both good fodder, but are not attended to here except by burning, and are not made as useful as they might be. In fenced pastures these grasses might be fed down before flowering, or, if too abundant, they might be cut and made into hay. We seem to accept as inevitable the fact that the better kinds of grass are not to be looked for on much of the pasture and waste land. If the pastures were fenced I think we should see a vast improvement in the grasses commonly occurring.

It would be a great advantage also in a variety of ways if certain kinds of trees were planted through the pastures, the shade of which would be grateful to the animals. Many of the finer grasses grow well under some trees, while the trees themselves will yield useful fodder. This latter use is, I think, too commonly overlooked in Antigua. For this purpose several trees may be suggested, but none of them seem superior to the Jamaica Shade Tree which is well known here. This tree grows freely, grass grows well under it, it forms a pleasant shade, and the pods are freely eaten by animals. Again, I may refer to Jamaica which is in parts a fine pasture country, where one sees large stretches of country under grass and partly covered with fine trees, presenting such a picture as one longingly hopes may some day be seen in Antigua.

It does not seem unreasonable to hope that some day the regular cutting of grass for hay may be looked upon as a matter of course. With level pastures, not difficult to obtain, it would be an easy matter to cut grass by means of mowing machines, and then hay-making would become simple and inexpensive work.

Some care might be bestowed upon pastures in the way of looking after the water supply. It is now clearly recognized that several diseases are distributed by means of water and that infected animals afford a sure means of spreading these diseases to their fellows if they are able to infect the drinking water, while the disease will not spread from the animal, but must be transmitted by means of water. Portions of the pastures might be set apart and animals not allowed to feed upon them, they being reserved as collecting grounds for water and places for growing crops of fodder to be cut and not grazed. This is a large subject, and one on which our veterinary surgeons could give us some interesting information at one of our meetings.

By treating our pastures in a more careful manner they will become capable of carrying much larger herds, the animals will become more useful and more valuable, and the sufferings which ensue from a period of drought may be greatly minimised.

I may perhaps be allowed to say a word about the kinds of grasses which are met with here :—

Guinea grass	Para grass
Bahama grass	Sour grass
Hay grass	Bed grass

GUINEA GRASS, (*Panicum maximum, Jacq.*), is so well known and so highly esteemed in the West Indies that we may dis-

miss it with a very brief reference. It is one of the most valuable of tropical fodders. It requiries some little care and attention in its cultivation, usually it is cut and fed to the stock, or if it is grazed, resting periods must be allowed; it responds readily to manuring and cultivation. Tradition says that it was accidentally introduced into Jamaica in the form of seed, as bird food. For many years it has been one of the most valuable of Jamaican crops, since by its means the cattle and horses for which Jamaica is famous are raised.

PARA GRASS, (*Panicum muticum, Forsk.*). The many names by which this grass is known in various parts of the world would lead us to infer that it possessed valuable properties sufficient to attract considerable attention. It is known as Para grass, Scotch grass, Water grass, Buffalo grass, and by other names; while here in Antigua we have added another to the list, for it is known locally as Shand grass. Here, it is only known as a wild grass, and I am not aware that anyone has tried to cultivate it. In other places, for example in Jamaica where there are luxuriant paddocks of it, it is cultivated like Guinea grass is. The reports as to its ability to withstand drought are contradictory. It is usually found growing in moist situations, but I am informed that it will withstand drought very well. It is desirable that we should have more information on this point.

BAHAMA GRASS, or DEVIL'S GRASS, (*Cynodon Dactylon, Pers.*). A well-known grass, forming a beautiful turf when properly looked after. Is chiefly known here as a weed on cultivated land, and the coarse grasses appear to prevent it from growing freely on the exposed pastures.

SOUR GRASS, (*Andropogon pertusus, Willd.*). This grass constitutes one of the most useful fodders in Barbados, where it is cultivated in carefully tended paddocks, its hardy character and its ability to resist drought giving it a high value. Like some of the other Andropogons, it contains an aromatic principle, and on this account cattle unaccustomed to it at first refuse to eat it, but once they overcome their dislike to it they feed greedily upon it. (This reminds one of the habit of cattle in Montserrat and Dominica, where they are seen greedily feeding on the skins of the limes from which the juice has been expressed. Strange cattle will not eat these skins at first but they soon acquire the habit, particularly in times of drought when other fodder is scarce. The fondness for limes often grows to such an extent that cattle will eat the fruit from the trees.) It is a dry grass, containing less water than the majority of grasses, hence it forms an excellent feed and loses comparatively little in weight when made into hay.

HAY GRASS, (*Andropogon caricosus, Linn.*). This is an East Indian grass which has made its appearance in Antigua in some unexplained manner, and is spreading steadily to the exclusion of other kinds, a fact not to be regretted since it appears to have good points to recommend it. It does not appear to be known in other West Indian islands. It has the merit that cattle will eat it when in flower: they will also eat it when the flower stalks have dried up, but it is to be

feared that there can be comparatively little nutriment in the dry stalks. Later, when speaking of two other grasses, I will point out the importance of the fact that cattle will eat this grass when it has flowered.

BED GRASS, (*Sporobolus indicus, R. Br.*), known also as Paramatta grass, Tussock grass, Smut grass, Wire grass and by other names, is perhaps the commonest one on our poorest and worst pastures. It is very noticeable when in flower, the narrow spikes of blossom forming waving sheets of dry tough grass which animals will not eat, or only sparingly. The young leaves and shoots are, however, eaten freely, and hence arises the common practice of burning off the dry flower-stalks in order to obtain a fresh succulent growth palatable to stock. The nature of this grass seems to have done more than anything else to encourage the habit of indiscriminate burning of pastures which, in the opinion of most of us, is so disastrous and which will render the establishment of trees on our pastures and hillsides such a difficult task. Hence it is that we may congratulate ourselves on the appearance and spread of the Hay grass, which is eaten by animals even when it has flowered, so that the incentive to burning is removed. I regard Hay grass as an important ally.

This Bed grass is looked upon as a useful fodder in other parts of the world, and no doubt it would assume a higher place in our esteem were we to give it the care and attention required to encourage its good points and to check its bad ones. If grown as a pasture grass, efforts should be made to prevent its flowering, either by close feeding, necessitating the use of fencing for pastures, or it should cut for hay as soon as the flower appears. The rough kind of care bestowed on it by burning is to be deprecated on account of the many evils following.

Chloris barbata, Sw. is a very common grass of which I do not know the vernacular name, chiefly seen along roadsides and in waste places, and, unlike most of our pasture grasses, an annual. This grass, like the last, is freely eaten by stock before flowering but is refused by them afterwards. If encouraged as a pasture grass it would require to be treated somewhat in the same manner as the last named.

CENT. PER CENT. GRASS, (*Panicum prostratum, Lam.*) and RICE GRASS, (*Panicum colonum, Linn.*), well-known locally, are somewhat watery grasses in their fresh condition, but are very nutritious, forming excellent fodder when dry.

In addition to the above reference to the "*Kew Bulletin*" I may point out that there is an account of Sour grass, (A. *pertusus*), in the number for September 1895, p. 209, and analyses of five Antigua grasses in the number for May and June 1896.

I shall be glad if this contribution to the subject serves to elicit the opinions of those who, from their intimate local knowledge of matters relating to the care of animals and their food supplies, must necessarily possess a fund of information of interest and value to the island.

CACAO INDUSTRY IN GRENADA.

Cacao growing is the staple industry in the interesting island of Grenada. Its prosperity for many years when other portions of the West Indies were in a depressed condition was entirely due to the successful cultivation of cacao trees. With the view of drawing attention to the desirability of making every effort to maintain the productiveness of cacao estates in Grenada, the following interesting notes, written by Mr. George Whitfield Smith in 1892, are reproduced:—

"It is pleasant to notice one of the few instances in Grenada of a Cacao estate where, as the result of a careful system of manuring and draining, the proprietor gets from only twelve acres of Cacao a return equal to what many others receive from three times that area. I refer to Good Hope Estate in this island, owned by the Rev. G. W. Branch. On the advice of His Excellency Sir Walter Hely-Hutchinson, I called one morning on the proprietor, and was most courteously shewn over the whole plantation. Both Mr. Branch and his son, Mr. George Branch, most willingly afforded me all the information in their power. Wishing to be as clear as possible, I shall endeavour to adhere as closely as I can to Mr. Branch's replies to my questions concerning the working of his estate.

'I have been owner of the property for over twenty years. Good Hope contains 22 acres—eight acres of this are in canes and pasture. I estimate that the buildings, yard, and entrance occupy another two acres, so that my extent of Cacao cultivation cannot be much over 12 acres. I purchased the place for about £100; at that time it had a few neglected Cacao trees here and there. Many people ridiculed my attempt to grow Cacao there, as the land was considered by most persons as almost valueless for that purpose. However, be that as it may, I could easily borrow £2,000 to-day on its security if I wished to do so. My soil is rather poor for Cacao when compared with many other places; as you will see, in many places there is a bed of "tuff" not far from the surface, and you know, when the tap root of a Cacao tree touches this, there is an end of the whole matter.'

'How, then, do you account for the flourishing state of your trees, when, to judge from their size, the tap roots must long since have come into contact with this layer of "tuff"?'

'My Cacao trees have no need to drive their tap roots very deep, as I will shew you when we are going through the orchard. The Cacao tree is naturally a deep rooter, but if it can meet with its nourishment near the surface it will undoubtedly develop its feeding spongioles wherever that nourishment is, and that is what happens in the case of my trees.

'Please explain how you do this?'

'Willingly. My cacao orchards are, as you observe, on the slope of a hill, skirting the sides; therefore, among the trees, I have roads cut by simply digging down the slope to a level. These roads are sufficiently wide to admit the passage of a light donkey cart, and as they wind along the hillside in a

corkscrew fashion you will understand how they serve a two-fold capacity. First, they act as roads proper, and, secondly they act as drains, since a small canal always skirts the upper edge for the whole of their length. Thus I have my Cacao field drained at regular intervals, and, in addition, my donkey cart can carry manure to any part of my estate.'

'How do you apply your manure?'

'Very simply; I just have the cart filled, and the driver upsets it at regular distances over the lower edge of these roads. I then go round as I can find time and bury this in. I likewise collect all leaves and bush from time to time, and bury these also. You will now see the effects of my system. Look down on the ground; what you are walking on is not pure earth. Take up a handful of it. You will notice that it is a dense mass of fine rootlets or spongioles! These have been called into being from the amount of nourishing material which they find here ready for them, and have no need to go deep in search of food.

My system has converted the trees into surface feeders, and provided I keep them supplied with food I can fairly be said to have them well under control. Now, without manure the case is different: the tree has to push its tap-root deeper and deeper every year in search of food, often it strikes "tuff" or "clay," then death ensues. Even when this does not happen, it stands to reason that a tree with a single tap-root supplied with a few scanty and half-starved rootlets, is in a poor way when compared with my healthy and vigorous trees which have an abundance of young roots, all eagerly sucking up the plant food around them. The good effect of this is easily seen when comparing the returns I get with those of neighbouring planters.'

'What do you average as a return from your 12 acres of Cacao cultivation?'

'About 87 bags per annum. This would represent a trifle over seven bags to the acre.'

'The old trees which you found on the place 22 years ago must be very old by this time: do they still bear vigorously?'

'Yes: quite as well as the young ones, and they seem good for many years yet, thanks to my manure system.'

'What do you consider to be a good yield per tree in pods per annum?'

'It would be difficult for me to answer this, and, indeed, I have never kept a record. My trees practically never stop bearing, but my son counted 205 ripe pods on one of the trees, besides green fruit and flowers. As you can see most of them have each several dozen ripe fruit, green fruit, and flowers on them at the same time, so that my crop may be said to be continuous.'

'Do you purpose extending your cultivation?'

'No; the remaining portion of my land is too much swept by prevailing winds to be of any value for Cacao; besides, I find that it pays me better to keep a portion in cane cultivation or some other fodder, not from the profit to

be derived from sugar, but because it enables me to feed my stock; without this I could get no manure, and without manure I could get no Cacao. I look upon my stock, therefore, as part of my working capital. People here seem entirely to forget this. I very often hear them speaking of the hard work they are having to get their plantation "covered in" as they call it, but if they knew what I know, they would find it more to their interest to keep one-fifth of their plantation in pasture lands and fields of fodder plants, and to keep several head of stock to fertilize the other four-fifths.'

'What system do you adopt in storing your manure?'

'The old Barbados system, which I have found to work so well. I have all my animals kept in a pen, a portion of which is covered to afford protection in heavy weather. In this pen they stay nearly all the time that they are not in use. Their excrement is consequently collected in one place. I regularly cover this over with cut bush and litter, and at intervals I spread a layer of mould over it, and recover with litter. The result is, that at the end of a few months I have a mass five feet thick of the richest fertilizing material that I know of, and one that for our generous soil needs little assistance from chemical manures. In addition to this I use a large quantity of sheep manure, which I collect in a similar manner from my sheep farm at Point Saline.'

'Do you ever transplant your trees?'

'Often; and here, again, the beneficial effects of my system become apparent. I take up large trees with pods on them. There is no danger, not being deep feeders, they give little trouble. When a gap occurs through the death of a tree I fill it up as soon as possible.'

'What do you do in the way of pruning?'

'I go through regularly and often, and break off all young shoots, and cut out any dead wood. You will see that my trees are perfectly clean of vines and lichens. A tree can't be healthy that has the pores of its bark stopped with roots of parasitical plants.'

'What is your opinion about shade?'

'I find in my locality that shade is beneficial in the growing stage, but is inimical when the tree commences bearing, at least heavy shade is. This holds good with even the "Criollo" Cacao, of which, as you see, I have a large number. With me this is one of the hardiest varieties, and bears profusely. My trees have crossed with each other and now I have a great number of varieties shading off one into the other.'

'Do you use any care in selecting seed?'

'At first I was anxious to get my land planted up, so raised whatever seed I could get. Now, I select and replace a bad variety with a good one whenever opportunity offers.'

'Do you grow other products with your young Cacao?'

'Always; such crops as yams, tannias, cassava, and canes come well with young Cacao, and, in my opinion, rather do

it good than otherwise, besides yielding catch crops of considerable value.'

What process do you adopt in picking and curing? Do you separate the different varieties before sweating?'

'With a small cultivation like mine it would be difficult to get a sufficient quantity of Criollo or any other variety at any one time to set up separate sweating boxes. I see the advantages of it, and regret that I cannot do so. My last account sales, however, are very satisfactory, and shew a receipt of 72 shillings per cwt., which, taking all things into consideration, is very fair indeed. The process of curing is that generally pursued in Grenada, and needs no special explanation.'"

More recently the following suggestions have been prepared by this Department with the view of assisting local efforts to maintain and improve the cultivation of cacao trees in Grenada.

Commissioner of Agriculture to Governor of Windward Islands.

BARBADOS, 26th May, 1899.

SIR,—I have the honour to forward for Your Excellency's information a Memorandum in duplicate prepared by this Department containing suggestions for renovating old and neglected cacao trees on the upper lands of Grenada.

2. During my recent visit to the island it was very forcibly impressed on my mind that, although the cultivation of cacao is steadily extending in the lowlands, the original areas planted in the mountains are gradually becoming unproductive. Hence it is that the exports of Grenada cacao have not increased in proportion to the area actually planted.

3. In the general welfare of the island it is desirable that the old cacao areas should receive special attention. Now prices are good is a favourable opportunity for doing so, and I would suggest that the subject be brought before the Grenada Agricultural Society with the view of eliciting the opinion of the members in regard to so important a matter.

4. It is possible that the Agricultural Society might assist small cultivators by affording information in regard to the best means for obtaining suitable manures at the lowest possible cost. It is desirable that all artificial manures supplied in the island should be sold under a guarantee that they contain the percentage of ingredients and the composition stated in the invoice. I would add that certified samples of imported manures forwarded to this office by the Government with a copy of the invoice would be analysed free of charge.

I have, etc.,

(Sgd.) D. MORRIS.
Commissioner of Agriculture
for the West Indies.

MEMORANDUM on methods to restore old and neglected cacao trees on the upper lands of Grenada.

1. *Pruning.* All neglected and badly formed trees should in the first place be carefully pruned. This operation might be undertaken after the crop, possibly the months of February, March or April would suit for this work. Cut out all dead wood and unhealthy branches. The utmost care should be taken to make all cuts perfectly clean, and as close to the main limb as possible. Too much importance cannot be attached to this point, especially as it is a practice in the West Indies to leave a small stump, of an inch or two in length. Whenever this happens it will be noticed the stump dies and decay spreads into the heart of the tree. Always trim the edges of a cut with a sharp knife. This ensures a more rapid healing of the wound.

In the case of specially old cacao trees, it would be a good plan to make use of a sucker, preferably one springing from a point near the root, and allow it to grow up in the place of a parent tree. The old stem should then be gradually removed. By adopting this method and by paying proper attention to tillage and draining it is quite possible to transform, in a short time, an apparently hopeless field of old cacao stems into a healthy bearing one.

In very extreme cases it may be necessary to remove the parent stem altogether. This should be done about 2 feet from the ground, and one of the suckers allowed to grow up as described above. Where the main stem is entirely taken away the cut should not be made horizontally across the grain of the wood, but in a sloping direction, say at an angle of 45°. The former method is strongly to be condemned as it allows the accumulation of rain water in the wood, tending to rot the stem and destroy the suckers.

Lastly, it is advisable to dress all cuts with a mixture of coal tar and whale oil, in equal proportions. This not only encourages the formation of new tissues, but safeguards the wounds from the effects of rain and the attacks of the borer and other enemies of the cacao tree.

2. *Cleaning the trees.* By this is meant the removal of moss, "Capitaine du bois" *(Loranthus)*, "Love vine" *(Cuscuta)*, and any other of the numerous parasitical plants which infest neglected cacao trees on the upper lands. The best season for this operation is during March and April. Showery weather should be selected if possible, as at that time moss is easily removed, without the least injury to the bark of the tree. Blunt knives made of bamboo or preferably stiff fibre brushes should be used for the purpose. For removing "Capitaine du bois" all that is required is an ordinary cacao picking knife attached to a long stick of bamboo. Care must however be taken to completely remove the plant, as any portion of it left on the branch of a tree rapidly grows again. The removal of the "Love Vine" (*Cuscuta*) is a more tedious operation. The only way in which it can be dealt with is to employ boys to climb the trees and to remove every particle of the plant by hand. The smallest portion left on a tree rapidly grows again. When this pest once

becomes thoroughly established in a cacao field, it is then a most expensive matter to eradicate it. Apparently the plant is spreading in Grenada and every effort should therefore be made to keep it in check.

3. *Forking.* With regard to the amount of forking required for a cacao tree, the opinions of planters vary considerably. While some planters claim to have obtained the best results from a system of deep forking and liberal root-pruning, others maintain that they prefer a light turning over or loosening of the soil with as little disturbance to the roots as possible. It is quite probable in the case of a perfectly healthy cacao tree with a well balanced head and a full supply of leafy branches, that any great disturbance of the root surface would not be beneficial. These conditions however do not apply to neglected cacao trees on the mountain slopes. Such trees, as a rule, have few branches; this indicates that they also have a correspondingly limited amount of roots. Deep forking and draining will be of immense value wherever this occurs. Care must be taken not to mutilate or break the large roots, as these serve to secure the upright position of the tree in the soil. Any of the smaller roots which are unavoidably broken, during the operation of forking, should be cleanly cut back. New roots will spring from this point and continue to nourish the tree.

Forking, by turning up soil, exposes it to the action of the sun and air. By this means the soil is loosened, the capacity for retaining air and moisture much increased, while at the same time the removal of excess of moisture is greatly facilitated. As a rule, it will be noticed that the soil around the roots of old and neglected cacao trees is water-logged and unwholesome. No air can penetrate into it; and, as the roots can only develop when air is present, it follows therefore that the growth of healthy rootlets in such a soil is completely checked. It is also well known that chemical change can only take place in the presence of air. Such a change therefore is not only arrested, but injurious combinations arise which discourage or destroy the roots of plants. It is therefore evident that judicious forking increases the porosity of the soil. Its effect is further strengthened if all leaves and vegetable refuse are dug in at the same time. Vegetable refuse or humus performs a most necessary function in damp clay. It serves to keep the small particles of the soil farther apart, and it thereby permits the free admission of air, on which so many important changes and combinations depend. It is doubtful whether it would be found advisable to bury vegetable refuse in a green condition in damp mountain lands. A better plan would be to allow it to become withered for a few days before digging it in.

4. *Draining.* This naturally follows the operation of forking. When heavy rains fall on clay lands a certain quantity of the water is absorbed by the soil and the remainder either lies on the surface or is carried away by drains and streams. Some soils are extremely porous and rapidly part with their moisture after heavy rains. Clay soils, on the other hand,

retain water for too long a time, and thus become old and sour. The only remedy for this is drainage.

It being established therefore that land is drained with the two-fold object of removing superfluous moisture and of promoting a free circulation of air, it is important to remember that, unless the water in a soil is kept in circulation, no air can enter between the particles of it. On damp mountain lands drainage has also another important office. It prevents landslips and washes. The rainfall is usually abundant in such localities and the soil cannot absorb the water as fast as it falls. Hence landslips occur. This never happens in forest land, because the soil is bound together with a network of roots. When however the forest is destroyed, and the land tilled and planted with cacao, the loose soil is then easily swept away by heavy rains. After a shower each stream and watercourse demonstrates most clearly that a large quantity of surface soil has been carried away, until finally, unless care is taken to prevent this by a proper system of drainage, there is nothing left but the bare sub-soil from which cacao trees cease to obtain any nourishment.

Surface drainage is the only method practicable in cacao fields. All such drains should be carefully laid out with a view to prevent washes. No drain should be made straight up and down the face of a hillside. Advantage should be taken of ravines and natural water courses wherever they occur and "contour" drains, 18 inches wide and 2 feet deep, should be regularly led into them at a distance of 40 to 50 feet apart. These drains should be made at an incline of 1 foot in 15, according to the steepness of the land. By having a system of drains made at an easy gradient, such as that above described, it is possible to recover a large quantity of the soil washed out of the land. It might be found beneficial to have all contour drains cleaned out at regular intervals during the rainy season and the mould spread between the trees.

5. *Manuring* is the next step necessary to restore old cacao trees. Manures supply the soil with the food required by the plants. This food may be either deficient in the land itself or taken out of it by cultivation. To the small grower pen manure would probably prove of the greatest value. Pen or farmyard manure is what is known as a general manure, and can be applied with safety to all soils and to all plants. It is of the greatest value, not only on account of its manurial action, but also on account of the mechanical action, which the burying of large quantities of trash and other refuse exercises on the particles of the soil. Pen manure should always be applied about 4 feet from the stem of the tree, in a shallow trench, and should be lightly covered with soil. In cases where the soil has been long neglected and contains a large amount of sour organic matter, it may be found necessary to apply a top dressing of lime, a few months before using farmyard manure. Lime acts beneficially in many ways. It decomposes all kinds of vegetable matter in the soil and corrects any acidity due to the presence of organic acids. It also has a good effect on the mechanical condition of soils. On

stiff and retentive clays it pulverizes and lightens the particles, thereby improving the drainage and reducing any undue excess of organic matter. On soils deficient in available lime a top dressing of about 4 tons per acre would probably be required. When applying calcareous manures they should be kept near the surface and not deeply buried in, as lime quickly sinks into the soil and has a tendency therefore to run away from the roots of the plants.

Artificial Manures. Professor Harrison after an exhaustive examination of the soils of Grenada recommends generally Basic Slag or Thomas' Phosphate powder. This should be applied broadcast in quantities of about 2 lbs. per tree on the forked surface. It should afterwards be lightly worked in and a top dressing of about ¼ lb. of nitrate of soda or sulphate of ammonia per tree may subsequently be given.

Governor of Windward Islands—to Commissioner of Agriculture.

Windward Islands.
Miscellaneous.
No. 72. Grenada, 31st May, 1899.

Sir,—I beg to acknowledge and thank you for your interesting and useful letter G. 1439 of the 26th instant embodying suggestions for dealing with old and neglected cacao trees.

2. I have directed the publication of your letter in the Official Gazette. It will also be laid before the Grenada Agricultural Society as you desire.

3. Too much importance cannot be attached to the question of the suitability and composition of artificial manures locally imported for use in the island. I had intended to have earlier written to ask you what quantity of each kind you required, and would suffice for purposes of analysis. Would it not help the question to have also specimens of soil from exhausted cacao areas? Kindly let me know.

I have, &c.,

(Sgd.) ALFRED MOLONEY,
Governor.

SOME FUNGI OF THE CACAO TREE.

(With plate.)

BY J. H. HART, F.L.S.,
Superintendent, Royal Botanic Gardens, Trinidad.

One of the earliest records of disease among cacao trees is that given by Long in his history of Jamaica. In 1671 Long states that there were as many as sixty-five "walks" in bearing,

while in 1882, only small patches, of no great extent remained. Loug also records that the Plantations were destroyed by a "blast."

What this blast was there is little evidence to prove, but taking one interpretation of the word, "to strike with some sudden plague," it may possibly have been occasioned by the rapid spread of some indigenous parasitic fungus. The time of the occurrence has been fixed by a 19th. century writer as "sometime during the last century."

The late Sir L. A. A. De Verteuil, K.C.M.G., M.D., in his book on Trinidad, page 431, states: -"The prosperity of the Colony had now reached its culminating point, Cacao selling at a high price. But in the year 1727 according to Guimilla, not a disease exactly, but a blight attacking the pods under certain atmospheric influences, destroyed the crop." Later, he records that the *Forastero* variety was introduced and succeeded beyond expectation, and writes. "It is this quality which is cultivated in our days."

In 1898 attention was specially called to a disease which attacked the pods of cacao destroying a large percentage of the crops in many districts in Trinidad.

The matter was taken in hand by the Botanic Department and close investigation showed that the pods were destroyed by a parasitic fungus which could be speedily propagated by inoculation with spores taken from diseased fruit. Several cultures of the fungus were made, and these, with other living materials were sent to Kew for examination and report.

The results of this examination were published in the "*Kew Bulletin*" for January and February 1899, as follows:—

"Microscopic examination revealed the presence of two distinct fungous parasites; one being the well-known *Phytophthora omnivora*, De Bary, a species closely allied to *Phytopthora infestans*, De Bary, the cause of the potato disease; the other a *Nectria*, which proves to be new to science, and will be known as *Nectria Bainii*. The *Phytophthora* was present on all the pods sent and may be considered as the cause of the present epidemic in Trinidad.

The same, or a closely allied species, appears to be the cause of the cacao-pod disease in Ceylon."

PHYTOPHTHORA OMNIVORA. *De Bary.*

"This fungus, as indicated by its specific name, is not fastidious in its choice of a victim, and has been recorded as attacking various species of plants belonging to the following genera:—

Acer, Alonsoa, Abies, Cleome, Clarkia, Cereus, Epilobium, Fagus, Gilia, Larix, Lepidium, Melocactus, Œnothera, Picea, Pinus, Solanum, Sempervivum, Salpiglossis.

If the fungus is confined to the fruit of the cacao tree it is obvious that infection each season must necessarily be derived from some outside source, the spores for this purpose being in all probability often produced on diseased fruit or "shells" lying

on the ground under the trees; nevertheless, being able to live on such a variety of host-plants, infection of a plantation for the first time might very possibly be attributed to wind-borne spores produced on some other kind of host-plant. This may appear to be poor consolation. However, it is well to be in possession of all known facts and possibilities in connection with the subject under consideration. The life-history of the fungus is well known, having been carefully studied by DeBary, Hartig, and others.

The conidial form of fruit appears as a very delicate white mould on the surface of the part attacked. The conidia or reproductive bodies are ovate or egg-shaped, being attached at the broad end to a very slender stalk, which shrivels and liberates the conidium when mature. This condition of the fungus flourishes for a few weeks during the period of active growth of the host-plant; and as the conidia are produced in immense numbers and in quick succession, and are dispersed by wind, insects, or rain, being washed from diseased parts of a tree to healthy parts, it can readily be understood why the pest spreads so quickly when once established. Conidia that happen to alight on young pods germinate at once, penetrate the tissues, and quickly produce a new centre of disease which furnishes more conidia in due time.

During the period occupied in the production of the external form of fruit described above, the mycelium of the fungus spreads rapidly in the substance of the pod and gives origin to a second form of fruit imbedded in the tissue of the pod. These reproductive bodies, known as resting-spores, remain for some months in a passive condition, and are eventually liberated by the decay of the pod: when they germinate, the bodies produced on germination being conveyed by wind to the young pods, germinate in their turn, enter the tissue, and in a few days' time produce the conidial form of the fungus on the surface of the pod.

Preventive Measures.—If it is ascertained that the fungus is not harboured by the other plants growing in the neighbourhood of the plantation, but is confined to the cacao trees, then prevention becomes an easy matter. It depends on having every diseased fruit collected and burned; for the only possible cause of infection in the first instance must arise from the germination of resting-spores developed in diseased pods, and so long as these are allowed to remain on the ground under the trees the disease will continue to spread. But the fungus may also attack other wild plants, and thus become firmly established and defy extermination.

The following measures should be taken to combat the disease:—

(1) Spray with Bordeaux mixture, commencing when the pods are quite young, and continuing at intervals of ten days.

A dilute solution should first be used until its effect on the fruit and foliage is ascertained. A small quantity of dried blood should be dissolved and added to the mixture; its adhesive property is much increased and fewer sprayings are required.

(2) Remove all diseased fruit from the tree, if practicable, otherwise a continuous supply of conidia will be furnished until the fruit decays. Do not allow diseased fruit or "shells" to remain on the ground. All such should be collected and burned.

(3) Endeavour to ascertain, by careful examination, whether the fungus may not be also parasitic on other hosts; it very frequently attacks seedlings, and would be recognised by the wilting of the attacked parts, and by the delicate white mould-like conidial form of reproduction."

The disease had some years previously been observed in Trinidad, but no special study was made of it. It was detected by Professor Harrison in Surinam, and in Grenada by Mr. G. Whitfield Smith, but little notice however was taken of it until the end of the year 1898, when its rapid spread caused some alarm.

The disease was observed to be most prevalent in places where the atmosphere was humid and where the pods had been allowed to rot beneath the trees.

NECTRIA BAINII, *Massee.*

"This parasite causes semi-circular dark blotches to appear on the pods, the diseased portion becoming soft and watery. At a later stage the blotches become covered with a lovely interwoven layer of yellowish-rust coloured or orange mycelium which is studded over with the minute red perithecia or fruiting organs of the fungus.

This parasite may possibly be quite rare, but great care should be taken to arrest any attempt on the part of the fungus to attack the trunk of the cacao tree, for as already stated the destructive canker disease of Ceylon is caused by a *Nectria.*"

"*Nectria Bainii*, Massee.—*Perithecia* gregaria," mycelio maculiformi flavo—ferrugineo vel aurantiaco insidentia, sphaeroidea, rubra, lanosa, denum supra calvescentia, 300-350 *Microns* diam. *Asci* cylindraceo-clavati, breviter pedicellati, octospori, 80 - 90 × 7 - 9 *Microns* *Sporæ* distichæ, oblongo-ellipticæ, utrinque subacutæ, 1 septatae, 10 - 12 × 5 *Microns* hyalinae."—Geo. Massee.

"The *Nectria* appeared on two pods, and this again possesses many points in common with the *Nectria*, which has caused such destruction to cacao trees in Ceylon by attacking the bark of the trunk and branches, as described by Mr. J. B. Carruthers. At present, no mention is made of other than the pod disease in Trinidad, but the fact of a parasitic *Nectria* being present, necessitates the prompt execution of measures calculated to prevent the parasite from extending its ravages."

It will be seen therefore that the Kew authorities were of opinion that the *Phytophthora* was the cause of the destruction of the pods, and later evidence appears to confirm this view.

There is however considerable danger to be apprehended from the spread of *Nectria*, or second species discovered.

Subsequently another, and yet un-named, species of *Nectria* has been found destroying the bark of cacao trees in Trinidad. Thus there are three distinct fungi, which are known to attack cacao trees in Trinidad.

It has been found that *Phytophthora* attacks pods at all stages of their development and frequently when partly ripe, and experiment proves that, owing to the attack of the fungus, there is a loss of weight of 25 per cent. in the beans produced, and, at the same time, a very considerable fall in their quality.

In the old authorities quoted, there is some evidence that a disease existed which was very destructive to cacao, but the exact nature of which was undetermined. It is further reported that it was impossible to grow the indigenous varieties and an imported strain was introduced which proved to be more hardy.

From the results of the attacks recently experienced coinciding in some points with the old records it is probably to be inferred that the diseases of the 18th. century were similar visitations to those of recent years.

There is distinct evidence, however, that the older kinds of cacao were not wholly obliterated, and that the introduced variety has since intercrossed with the original. It does not appear, however, so far as present information goes, that those strains bearing greater relation to the indigenous types, are more susceptible to disease than *Forastero*, for the latter appears to suffer equally with others from the attack of *Phytophthora*.

The evidence in support of the view that the older "blasts" and "blight," attacking the pods a century ago, are the same as those of to-day, is incomplete and wanting. The probability, however, that they are identical is an impression which is widespread.

It would be no little satisfaction to the planter if they could be proved identical, as it would show the intermittent character of the pest, and relieve growers of the fear of constant attack. A fact, which favours their being identical, is their partial disappearance during the dry season of 1899 and 1900. This may however be due partly to the adoption of the measures of prevention which were recommended. So far as can be gathered from the evidence at present to hand, it would appear that although these fungi have only recently been discovered, and their life history and destructive character made known, it is probable that they have always been present, and, if sufficient care is exercised, may be kept within due bounds, and will not succeed in seriously damaging the crops. The character of the organisms and their mode of reproduction teaches that the careless and untidy planter will be the greatest sufferer, when a succession of seasons are experienced favourable to their growth ; while he who keeps his cultivation clean, and in good order may expect to escape with minor injuries.

EXPLANATION OF FIGURES IN PLATE.

Illustrating the article on Some Fungi of the Cacao Tree.

Fig. 1. *Phytophthora omnivora.* Section of a portion of a cacao fruit, showing the conidial form of repro-tion of the fungus on the surface, × 300.

Fig. 2. A conidium of the same germinating, × 300.

Fig. 3. Oospores of the same produced in the diseased tissue of a cacao fruit, × 400.

Fig. 4. Pustule of *Nectria* bursting through the skin of a cacao fruit, and producing the conidial form of reproduction, × 40.

Fig. 5. Portion of conidial form of fruit, × 400.

Fig. 6. Free conidia of the same, × 400.

Fig. 7. *Nectria Bainii.* Surface view of sporophores seated on a byssoid stroma, × 50.

Fig. 8. Three perithecia in different stages of development, shewing the byssoid covering of the exterior.

Fig. 9. Asci, × 400.

Fig. 10. Germinating spores of the same, × 400.

Fig. 11. Asci of a saprophytic species of *Nectria* appearing after the fruit is dead, × 400.

Fig. 12. Spore of the same shewing the granular protoplasm; the epispore is smooth, × 1,000.

AGRICULTURAL EDUCATION IN ENGLISH RURAL SCHOOLS.

The following letter recently issued by the Board of Education in England, and signed by Sir George W. Kekewich, K.C.B., relative "to the importance of making the education in the village school more consonant with the environment of the scholars than is now usually the case, and especially of encouraging the children to gain an intelligent knowledge of the common things that surround them in the country," is reproduced for the information of the Managers and Teachers of schools in the country districts in the West Indies.

There is also reproduced a circular on the same subject issued by the Board in 1895.

Circular 435.

BOARD OF EDUCATION,

Whitehall, London, S.W., April, 1900.

SIR,

The Board of Education are anxious to call the attention of Managers and Teachers of Elementary Schools situated in the agricultural districts of England and Wales to the importance of making the education in the village school more consonant with the environment of the scholars than is now usually the case, and especially of encouraging the children to gain an intelligent knowledge of the common things that surround them in the country. From experience gained in various districts it is found that by a suitable arrangement and handling of the school curriculum this object can often be attained without necessarily adding any new subjects to the time-table, or demanding any undue burden or work from teachers or scholars.

The Board would deprecate the idea of giving in rural elementary schools any professional training in Practical Agriculture, but they think that teachers should lose no opportunity of giving their scholars an intelligent knowledge of the surroundings of ordinary rural life and of shewing them how to observe the processes of Nature for themselves. One of the main objects of the teacher should be to develop in every boy and girl that habit of inquiry and research so natural to children; they should be encouraged to ask their own questions about the simple phenomena of Nature which they see around them, and themselves to search for flowers, plants, insects and other objects to illustrate the lessons which they have learnt with their teacher.

The Board consider it, moreover, highly desirable that the natural activities of children should be turned to useful account—that their eyes, for example, should be trained to recognise plants and insects that are useful or injurious (as the case may be) to the agriculturist, that their hands should be trained to some of the practical dexterities of rural life and not merely to the use of pen and pencil, and that they should be taught when circumstances permit, how to handle the

simpler tools that are used in the garden or on the farm, before their school life is over.

The Board are of opinion that one valuable means of evoking interest in country life is to select for the Object Lessons of the lower Standards subjects that have a connection with the daily surroundings of the children, and that these lessons should lay the foundation of a somewhat more comprehensive teaching of a similar kind in the upper Standards. But these Object Lessons must not be, as is too often the case, mere repetitions of descriptions from text-books, nor a mechanical interchange of set questions and answers between teacher and class. To be of any real use in stimulating the intelligence, the Object Lessons should be the practising ground for observation and inference, and they should be constantly illustrated by simple experiments and practical work *in which the children can take part*, and which they can repeat for themselves at home with their own hands. Specimens of such Courses can be obtained on application to the Board of Education. These may be varied indefinitely to suit the needs of particular districts. They are meant to be typical and suggestive, and teachers it is hoped, will frame others at their discretion. Further, these lessons are enhanced in value if they are connected with other subjects of study. The Object Lesson, for example, and the Drawing Lesson may often be associated together, and the children should be taught to draw actual objects of graduated difficulty, and not merely to work from copies. In this way they will gain a much more real knowledge of common implements, fruits, leaves and insects than if these had been merely described by the teacher or read about in a lesson-book. Composition exercises may also be given—after the practical experiments and observations have been made—for the purpose of training the children to express in words both what they have seen, and the inferences which they draw from what they have seen; and the children should be frequently required and helped to describe in their exercise books sights of familiar occurrence in the woods and in the fields. Problems in Arithmetic connected with rural life may also be frequently set with advantage.

The Board of Education also attach considerable importance to work being done by the elder scholars outside the school walls, whether such work takes the form of elementary mensuration, of making sketch-plans of the playground and the district surrounding the school, of drawing common objects, of paying visits of observation to woods, lanes, ponds, farms and other suitable places under the guidance of the teacher, or of the cultivation of a school garden.

The teacher should as occasion offers take the children out of doors for school walks at the various seasons of the year, and give simple lessons on the spot about animals in the fields and farmyards, about ploughing and sowing, about fruit trees and forest trees, about birds, insects and flowers, and other objects of interest. The lessons thus learnt out of doors can be afterwards carried forward in the school-room by Reading, Composition, Pictures and Drawing.

In this way, and in various other ways that teachers will discover for themselves, children who are brought up in village schools will learn to understand what they see about them, and to take an intelligent interest in the various processes of Nature. This sort of teaching will, it is hoped, directly tend to foster in the children a genuine love for the country and for country pursuits.

It is confidently expected that the child's intelligence will be so quickened by the kind of training that is here suggested that he will be able to master, with far greater ease than before, the ordinary subjects of the school curriculum.

The Board would further urge upon any teachers now in rural schools who happen themselves to be of urban up-bringing or to have been trained in urban centres, to seize every opportunity of gaining a closer insight into the special conditions and problems of rural life, and they trust that those whose previous education has not enabled them to obtain full knowledge of the main principles and phenomena of rural life and activities will be able to attend such holiday courses and classes as may be placed within their reach for this purpose by County Councils or other Local Committees; since it is only when the teacher is genuinely interested in, and well informed about, the occupations of country life that any such results can be looked for in the children as have been referred to as the proper object of rural schools in the present Circular.

I have, etc.,

(Sgd.) G. W. KEKEWICH.

Circular 369.

EDUCATION DEPARTMENT, WHITEHALL, LONDON.
25th June, 1895.

SIR,

It has been observed that in schools in which Object Teaching has been introduced with most success the teachers have carefully distinguished between two kinds of instruction which in other schools are not seldom confused. These two kinds of instruction are—(1) observation of the Object itself, and (2) giving information about the Object. This distinction is of importance, because the scope and method of the lesson differ according to its nature. Object Teaching leads the scholar to acquire knowledge by observation and experiment; and no instruction is properly so-called unless an Object is presented to the learner so that the addition to his knowledge may be made through the senses.

Junior teachers have not unfrequently given lessons before H. M. Inspectors which were wrongly described as Object

Lessons because in dealing with the topic selected no suitable appeal was made to the eye of the scholar. A lesson, for example, on the elephant to children in village schools, who have no opportunity of visiting either Museums or Zoological Gardens, may convey information and store the memory with interesting facts, but it does not cultivate the habit of obtaining knowledge directly and at firsthand, or develop the faculty of observation. However well the lesson may be illustrated by diagrams, pictures, models, or lantern slides, if the children have no opportunity of handling or watching the actual object which is being dealt with, the teacher will be giving an Information Lesson rather than an Object Lesson. It should be always remembered that in Object Lessons the imparting of information is secondary to the cultivation of the faculty of observation.

Object Teaching should further be distinguished from Instruction in Natural Science. It is Elementary Science only in so far as it aids the child to observe some of the facts of nature upon which Natural Science is founded; but as it deals with such topics without formal arrangement, it differs widely from the systematic study of a particular science. The principles of scientific classification, the continuous study of one group of natural phenomena, the generalisation from facts and the search for natural laws, belong to a later stage of mental discipline, which will be much more effectual if it is being based upon the preliminary training of the senses through sound Object Teaching. It is most important, therefore, that if, for example, Object Lessons are given on plant life, no attempt should be made to treat them as a continuous introduction to the study of Botany, or, if the lessons relate to animal life, to the study of Zoology. In Object Teaching the chief interest in the lesson should centre in the Object itself.

The following suggestions which have been made by practical teachers, will be found useful :

(1.) The teacher should select only so many of the Objects set forth in the appended or other similar lists as can be dealt with in the year without overburdening the scholars. Habits of observation are better cultivated by the thorough examination of a few objects than by the superficial treatment of many.

(2.) No object should be chosen which the teacher cannot thoroughly illustrate either by the Object itself or by some adequate representation of the Object, or by both. All that is purely technical, whether in the mode of study or the language and terminology, should be carefully avoided.

(3.) The children should be encouraged to bring with them to the lesson illustrative specimens which they have collected or borrowed from friends.

(4.) The children should be encouraged to make simple drawings illustrative of their observations, wherever possible, and in certain cases to make simple records on square-ruled paper. Clay modelling and other manual occupations may be employed to test the accuracy of the impressions which the children form, and to fix them in their minds. Teachers also should frequently illustrate details of the lesson by black

board drawings. Children who are jaded in five minutes by a lecture will be open-eyed and receptive for half-an-hour while the teacher draws as well as talks.

(5.) Visits to Museums, Art Galleries, and other places of educational value, or of national or historical interest, are now recognised by the Code, and may advantageously be undertaken where possible in connection with the Object Teaching. Occasional class excursions out of school hours (or, if the instruction be in accordance with Art. 12 *(f.)* of the Code, in school hours), under proper guidance, will enable teachers both to provide suitable Objects and to confirm previous impressions. It should be borne in mind that Objects, when they are brought into the class room, cannot be there studied under their ordinary conditions; and therefore it is important by a proper use of such expeditions to let the children see what part the Object plays in its usual surroundings.

(6.) If the scholars are to learn intelligently from their Object Lessons, the first requisite is trained attention. The right method of securing this is to direct, in a conversational way, the attention of the children to the different parts of the object in an orderly manner, and explain the relation of each part to the whole. After the analysis or study of separate detail, the object should be again treated as a whole. It should not be left in fragments, but the division into parts should be followed when possible by the reconstruction of them into their original unity. Through such teaching the vague and indefinite impressions which children receive from Objects when they are first presented to them are gradually converted into clear mental pictures.

(7.) The attempt to teach children to be accurate in observation cannot be separated from the need of making them accurate in description. After the children have been trained to observe a fact they should be practised in making a correct statement of it in a sentence of their own. This oral answering in complete sentences will lead to correct use of the English language, both in talking and writing, and will store the mind with a useful vocabulary. In the higher standards the children will be able to write brief weekly compositions in which they may express in a written form the ideas which they have acquired through oral instruction.

To sum up the main value of Object Teaching, there are three principal uses. The first and most important is to teach the children to observe, compare, and contrast; the second is to impart information; and the third is to reinforce the other two by making the results of them the basis for instruction in Language, Drawing, Number, Modelling, and other Handwork.

There are, however, other important uses of good Object Teaching. It makes the lives of the children more happy and interesting by opening up an easily accessible and attractive field for the exercise of brain, hand, and eye. It gives the children an opportunity of learning the simplest natural facts and directs their attention to external Objects, making their education less bookish. It further develops a love of nature and an interest in living things, and corrects the

tendency which exists in many children to destructiveness and thoughtless unkindness to animals, and shows the ignorance and cruelty of such conduct. The value of the services which many animals render to man should be dwelt upon, and the importance of kindly treating them and preserving them should be pointed out. By these means, and in other ways, good Object Teaching may lay the foundation for the right direction of the activity and intelligence of the children throughout the whole school.

I have, etc.,

(Sgd.) G. W. KEKEWICH.

OBJECT LESSONS.

The following lessons deal with the ordinary phenomena of common life and with objects familiar to the children. The teacher's choice is not confined to these lists; other objects will be accepted subject to the approval of the Inspector. Any of the objects may be dealt with at the discretion of the teacher in more than one lesson, and although they have been grouped for convenience of reference, it is not intended to prescribe any specified number of them for a yearly course. With different treatment the same object may be adapted to more than one standard. Some teachers may prefer to deal with the same object in successive years, or to recur to it after a year's interval, expanding the study to suit the growing powers of the scholars. To meet the varying requirements of teachers it will be noticed that in some cases the names of the objects have been merely enumerated, while in other cases a few suggestions have been added as to the mode of treatment.

I. PLANT LIFE.

(*a*.) *The Study of plants as growing things.*

Grow an onion in a bottle of water and note appearance of root and stem. Make a model in clay of the various stages of growth at short intervals.

Grow mustard seed on damp flannel and note stages of growth.

Notice a few curious roots.

The carrot. Cut off the top of one and grow it in a saucer of water. Contrast the root of a daisy (fibrous).

Roots which walk. Strawberry or strayberry.

Violet root.

Contrast roots of Iris and Solomon's Seal in their mode of extension.

Stem. Count the rings in a trunk that has been felled.

Rings, how produced; estimate age of tree; the record of wet or dry seasons.

Climbing stems. Ivy.

Train bindweed up a stick and note that it turns to the right. If you unwind it and force it the other way (to the left) note how it resumes its old direction again, holding the stick with one of its leaf stalks to get a purchase for the change.

Simple experiments to show effect of light on (1) leaves and (2) roots. Celery; blanching.

Leaves of deciduous trees contrasted with leaves of evergreens.

Contrast leaves of holly, ivy, and box with leaves of oak, elm, and beech.

Note autumn tints. Collect and press leaves of various colours in autumn.

Buds. Leaf buds and flower buds.

Parts of a flower.

Fruits. Different kinds.

(b.) Blossoms, Fruits, Seeds, and Leaves.

Parts of a flower.

Flowers of curious shape.

Pea blossom.

Insects and flowers.

Colours of flowers and insects.

Fruits. How seeds are scattered.

Shooting seeds.

Flying seeds.

Curious flowers, *e.g.*, primrose; compound flower (daisy); water lily.

Leaves. Shape, veining, arrangement.

Flowers as supplying (1) weather-glass, (2) clock, (3) calendar.

Examine celery plant. Cut leaf stalks into thin sections to see how a plant is built up.

(c.) How plants are adapted to their surroundings.

A bunch of spring flowers (according to time of year).

A bunch of summer flowers „ „ „ „

A bunch of autumn flowers „ „ „ „

Flowers and the soil. Bog plants.

Riverside plants.

Plants that grow in running water.

Plants that grow in still water.

Meadow plants.

Plants of the heath and moor.

Plants of the hills. Plants of the wood. Plants of the sea-coast and salt marshes.

Sundew and flesh-eating plants.

Ferns.

The spores of ferns.

Grow some spores in a pan under glass and watch growth and development of a fern. Contrast with growth of mustard from seed.

Mosses.

Lichens.

Funguses.

Simple experiments in manuring plants.

How plants help or hinder each other's growth.

Parasites. Mistletoe.

Plants which help or injure man.

II. ANIMAL LIFE.

(a.)

The Cat (compare with Dog). Eyes, rough dry tongue, soft pads and sharp claws, teeth, method of holding prey, drinking, covering of fur, whiskers, tail.

The Cow (compare with Sheep and Goat). How she takes her food, teeth, chewing, milk (cheese and butter), tail, hoofs, covering, ears, horns, nose.

The Horse, (compare with Donkey).—Covering, teeth, hoofs, tail, mane.

The Rabbit (compare with Hare). Teeth, legs, feet, claws, covering, tail, whiskers, ears, eyes.

The Mouse (compare with Rat and Water Rat).—Teeth, paws, tail, whiskers, eyes, ears.

A Fish.—How fitted to live in water, weight, shape, covering, temperature, movements.

A Plaice (compare with Herring).—Flat, eyes on one side of head, gills, movements.

Animals which sleep in winter. Examples: squirrel, dormouse, common snake, frog, toad, snail, slug. Preparation made for sleep.

Mole.—Shape, snout, teeth, paws, claws, eyes, ears, fur, food.

Hedgehog.—Covering of spines, how it rolls itself into a ball and why, head, teeth, food.

Common Snake (compare with Viper). Shape, covering, teeth, how it moves, how it swallows its prey.

Frog (compare with Toad and Newt).—Movement, capture of prey, breathing, winter quarters.

Garden Snail (compare with Slug).—Shell, mantle, head, horns, eyes, food, preparation for winter sleep.

Earth Worm.—Shape, rings, locomotion, food, usefulness.

Spider (contrast with Bee).—Shape, segments, legs, eyes, jaws, spinnerets, web, breathing organs.

Paws and Claws and their uses.—Cat, dog, rabbit, mouse, mole, frog.

Tails and their uses.—Horse, cow, donkey, dog, cat, monkeys, harvest mouse.

Tongues and their uses.—Cat, dog, cow, woodpecker, frog.

Teeth and their uses.—Man, cat, cow, horse, rabbit, snake, fangs of poisonous snakes.

Hair, Fur, Wool, and their uses.—Cat, mole, dog, sheep, fox.

Beaks of Birds and their uses.—Duck, fowl, parrot, sparrow, goat-sucker, heron.

Feet of Birds and their uses.—Duck, fowl, swift, owl, &c.

Insects.—Examples: bee, beetle, butterfly, cockroach, silkworm. Insect development, legs, wings, segments, mouth, breathing apparatus, ovipositors.

III. THE SKY, THE AIR, THE SURFACE OF THE LAND, AND WATER.

(a.) The Sky.

Sunrise, noon, and sunset. (Note the object over which the sun is seen to rise from month to month. Note sun's position at noon, and its varying height above horizon.)

Shadow. (Note by aid of a spike erect on a flat disc the varying length of the shadow at noon. Study the shadows of objects. Variation in sharpness and depth.)

Moon. (Note the changes. Draw the shape from week to week.)

A few of the brightest constellations. (Make diagrams on square ruled paper from a study of the sky itself. Great Bear and Pole Star; Lyra and Vega; Cassiopeia.)

Planets. (Note any planet visible when the lesson is given. Mark its position on square ruled paper for a few weeks.)

Varying length of day and night.

(b.) The Air.

Wind. Varying direction. (Note and keep record of the direction of the wind from day to day.)

Warmer and colder winds; rainy and dry winds.

Moisture in the air shown by seaweed; string (changing tension.)

Wet cloth dries in the wind (water turns to vapour.)

Vapours turn to water. (Breathing on slate. Clouds on hills. Evening mists.)

Clouds in the sky. Three chief kinds: "heaps," "beds," "feathers."

Rain. (Note size of drops. Raindrops on dust form little balls. Note effect of heavy rain in tearing up roads. Note the channels so made, and the arrangement of the sand and pebbles washed to a distance.)

Rainbow. (Note the succession of colours. Note position of sun behind observer and of the bow where the shower of rain

is falling. Note that height of arch changes. When is it higher and when lower?)

Rainbow colours on shells, film of tar, &c. Feathers of birds.

Dew. (Note when formed. Cloudless weather. On what does it lie thickest?)

Hoar frost.

Snow. (Note size of flakes. Movement of flakes in the air as they fall. Snowdrift. Snow squeezed into ice.)

Hail. (Note when it falls. Examine hailstones. Is the hail accompanied by thunder?)

(c.) The Surface of the Land.

Level or sloping. Simple way of measuring slope. Height of school and neighbouring hill tops above sea level.

Flow of water over the land. Neighbouring stream or streams. Water-partings.

The river basin in which the school is situated.

Construct a model fountain and make simple observations on the pressure of water. Milldam. A "head" of water. Notion of falling water as a motor.

Soils. Clay, sand, slate, granite, chalk, quarries near school, gravel pits, clay pits, brick works. (Note how the rocks lie, in layers or in masses without structure.)

Stones in the brook, water worn; pebbles on beach rounded; pebbles in gravel pit often with sharp edges, perhaps ice-borne.

Difference between sand and mud. Crumbling rocks. Effect of frost on damp rocks.

Caves by the sea formed by the waves; caves inland formed by rain dissolving limestone: stalactites. (A lesson for schools in limestone regions or near rocky coasts.)

Building stone, marble, slate, Bath stone, sandstone, &c.

In marble, note shells, &c. Note plants in coal.

Volcanic rocks. Lava, brimstone, pumice stone, basalt or whinstone. (According to the nature of the district.)

Rock salt; crystals of salt. Salt in sea water. Mineral in solution.

Hard and soft water. Rain water compared with streams from chalk or limestone; leavings after evaporation. Fur in kettles. Softening hard water.

(In certain districts) other minerals in solution, sulphur wells, iron springs, medicinal waters.

Mortar and cement. (Slake lime and make mortar; note the heat, &c.)

Surface soils. Crumbled rocks. Water-borne sand and mud. Vegetable mould and earth worms.

Vegetation and cultivation. Forest, moor and heath. Heathers.

Hedgerow trees, elms, ashes.

Trees of the forest, oak, beech, birch.

Evergreen trees, pines and firs.

Evergreen plants and shrubs, holly, ivy, box. Contrast evergreen and deciduous leaves. (Note changes at fall of leaf. Autumn tints. Press specimens.)

Riverside trees, willows, poplars, aspens.

Hill pastures and meadows. Turf on the downs and hay in the valleys.

Gardens and their contents. Garden fruits and wild fruits. Garden flowers and wild flowers.

(d.) Water.

Standing water: ponds: pond life.

Springs and running water. Clear water looks shallower than it is. Simple experiments in illustration.

Study of flow of a stream. Where the flow is quicker (*a*) in the middle: (*b*) on one side, outer and inner bend. Where the bank is eaten away and where sand is spread out. Varying bottom: deep pools, shallows, sand banks. Confluence of tributary. Delta. Measure the speed at which the water flows.

Study of seashore. Rocky and sandy coasts. Soundings. The rise and fall of the tide. Currents. Drifting sand. Effect of frost on cliffs. Breakwaters. Layers of soil and rock exposed down the side of a cliff.

Measure with thermometer the temperature of (*a*) a spring (*b*) a stream; (*c*) a pond; (*d*) the sea.

Ice. Study hardness, mode of fracture; splitting blocks with a needle. Does it sink or swim in water? Easy to make two surfaces of ice freeze together. Simple experiments with ice.

Watch and record behaviour of thermometer plunged in melting ice.

Melt some ice carefully to find out whether it takes up more or less room than the water into which it changes. (Force a mass of ice into a lump of clay and let it melt there.)

Freeze some water in a bottle and note bursting of bottle. Bursting of pipes.

Notes on expansion and contraction of substances illustrated by behaviour of water at different temperatures. Preliminary notion of thermometer.

Watch cold spring water being heated to boiling point in transparent glass vessel. Note bubbles of air given off, and as the water is heated bubbles of steam rising from below. Observe force of compressed steam. Preliminary notion of steam engine.

Dribble powdered alum into clear water. Hang thread in the solution and note the formation of crystal. Alum and other crystals.

Expose to the air crystals of (1) salt: (2) soda. Note change. What difference? What difference according to weather? Expose to the air crystals of saltpetre, and note result.

Dribble salt into clear water and note that it dissolves, quicker at first, then slower, at last no more is dissolved. Place

a fresh egg in the saturated solution and afterwards transfer it to clear water.

One liquid is denser than another. Compare water and mercury. Things which float in mercury and sink in water.

Upward pressure of water on bodies dropped into it. Why bodies sink or float. Why steel ships float. Why cork floats.

Simple experiments in displacement of water.

Simple experiments in pressure of water and pressure of air. Siphon. Squirt. Pump. Diving bell.

Distillation of water. Filtration.

Water: a combination of two gases, oxygen and hydrogen. Simple experiments.

IV. OBJECT LESSONS FOR TOWN SCHOOLS.

(*a.*)

The water we drink—how obtained.
Some of the simpler properties of water.
River (or canal)—according to circumstances.
Boats, barges, or ships, with which children are familiar—according to circumstances.
Other ships, *e.g.*, Atlantic liners.
Bricks—their size, shape, and manufacture; their size, &c., to be ascertained by children's measurements.
Bricklayer's work—arrangement of bricks in 14-inch wall and in 9-inch wall, shown with real bricks or with small wooden ones; mortar, &c.
Coal—its simpler properties.
Coal—how obtained.
Coal—how transported and how used.
Coal gas; it may be made in presence of the children.
Gas works and gas pipes.
Petroleum—how obtained; its simpler properties and uses.
Lamps and their dangers.
Common stones used in building and road making.
Road making and paving.
Quarries and quarrymen.
Railways—general sketch.
Engines and carriages.
The work of railway men.
The park or public garden—general sketch,
The park or public garden—one or two of its more conspicuous trees.
The park or public garden—one or two of its more conspicuous plants.
Comparison between calico and flannel.
Cotton and its manufacture.
Lancashire and the cotton district; mills.
Sheep-clipping and rearing.
The West Riding of Yorkshire; factories, &c.

(*b.*)

Cart-horse.
Donkey.
Sparrow.
Rat or mouse.
Cat.
Plants grown in schoolroom (acorn in glass of water).
Plants grown in schoolroom (mustard and cress).
Some common fruits sold in streets or shops, *e.g.*, cocoanuts.
Things seen in grocer's window, *e.g.*, tea.
Things seen in grocer's window, *e.g.*, sugar.
Things seen in grocer's window *e.g.*, coffee.

Plants grown in schoolroom (hyacinth in water or pot).
Plants grown in schoolroom (a fern).
Costermonger and what he sells.
Some common fruits sold in streets or shops, *e.g.*, pears and apples.
Some common fruits, sold in streets or shops, *e.g.* strawberries.
Some common fruits sold in streets or shops, *e.g.* oranges.
Things seen in grocer's window, *e.g.*, currants and raisins.
The baker and his work.
The milkman.
The addressing and posting of a letter.
The postman and Post Office.
The sweep and his work.
Dangers from fire, and how they may be avoided.
The fireman and fire-engines.
Bus or tram drives.
The policeman.

V. OBJECT LESSONS FOR COUNTRY SCHOOLS.

(*a.*)

The farmyard.—Its buildings and their contents. Animals kept on a farm and their uses. Necessity of cleanliness, kindness, and suitable food.

The dairy and its contents. Butter and cheese-making.

Bees.—Bee-keeping.

Spring.—Spring flowers. Work in the fields in spring. The cuckoo and swallow. Record date of arrival.

Summer.—Different kind of leaves and fruit. Work in the fields in summer.

Autumn.—Work in the fields.

A mill and the work of a miller.

Winter.—Frost. Ice. Snow.

Birds.—Singing birds, as the thrush and nightingale. Birds of prey, as the hawk. Swimming and wading birds, as the duck and heron.

Wild Animals.—The fox, hare, and rabbit.

Minerals. A mine. Three useful minerals.

The lessons on the seasons should correspond with the actual seasons of the year, and the different operations explained should be taken while each is in progress.

Leaves of trees may be dried by simply placing them between sheets of paper and pressing them. Their shapes may be used for the children to draw round on paper, which can afterwards be pricked and then sewn round.

(*b.*)

Springtime. { The waking of Nature.
The lengthening daylight in the morning and evening, the coming warm weather, birds singing, building their nests, laying their eggs, the trees and hedges changing, buds and leaves, the bloom on fruit trees. }

The local wild flowers of spring.—The daisy, primrose, blue bell.

Summertime.
The local wild flowers of summer.
Autumn.
The local wild flowers of autumn.
Winter. The repose of Nature.
The land.—Woodland, meadowland, ploughland, moorland.
The sky.

A bird—covering, wings, beak, feet; motion; nests, eggs, food.

Local birds. { Thrush or blackbird. Lark. Robin. Rooks.

Birds which come for the summer.
Birds which come for the winter.

Local wild animals. { Rabbit. Hare. Fox. Hedgehog.

Animals on a farm.
Our village.
The carrier's cart.
The cottage garden.

The stream or river, its banks, the birds and animals that live near it.

A fish.
A plant.

(c.)

The garden in spring.
The farm in spring.
The garden in summer.
The farm in summer.
The garden in autumn.
The farm in autumn.
The garden in winter.
The farm in winter.
The weather and wind.
The soil; sunshine, air, rain, frost, manure.
The farmer's tools.—The plough, drill, reaping machine.
The crops; grass, corn, root-crops.
Wheat.
The potato.
The oak tree.
The elm tree.
The apple tree.
Evergreen trees.
An insect.
The spider and his web.
The butterfly—colours, beauty, history.

Bees.
The farmer's pests.
The farmer's friends.
A pond.
A frog.
A ramble in a wood and what may be seen there.
The railway.
Market day in the neighbouring town.
A newspaper.

VI. OBJECT LESSONS IN THE SCIENCE OF COMMON THINGS.

(a.)

Water.—How carried, jugs, bottles, barrels, spouts, funnels. Wells. Things that float, things that sink.

Solids.—Hard and soft, in the room and in clothing. Files. Hammer and nails. Buttons.

Powders.—Flour.

Pastes.—Paste, clay, putty.

Things porous.—Bread, sponge.

Things that melt.—Butter, tallow, sealing wax. Ice, snow.

Water.—Drying clothes, breathing on slates, frost on the pane. The boiling of the kettle. The pot boiling over.

Things that dissolve.—Sugar, salt.

Air.—Bubbles, pouring water through funnel into empty bottle. A burning candle. Fans, blowing feathers. Paper windmills.

Forms of Strength.—The floor, joists and boards. Wooden bridges. Steps and stairs.

Things that stretch.—Elastic bands.

Things that bend.—Bow and arrows. Cords, ropes.

Machines.—Tops. Roller for pastry, for garden. Perambulator.

Movements.—Walking, running, leaping, creeping, crawling

Musical Toys.—Harmonicon. Bell.

(b.)

Water.—Pipes, taps, the fountain. Canals. Rafts, boats, anchors.

Solids.—Teeth, nails and claws. Sand-paper. Pins, needles, awl, gimlet. Hook and eye.

Powders.—Chalk, pencil.

Pastes.—Mud in streets, brick-making.

Things porous.—Brick, chalk, springs of water.

Things that melt.—Candle-making. Icicles.

Water.—Manufacture of salt from brine. Rain-drops, hail, spray, water-dust, the cloud.

Things that dissolve.—The manufacture of sugar.

Air.—The chimney, draughts. Waves and breakers. Winged seeds. Shuttlecock, arrow and kite.

Forms of Strength.—The ceiling. The arch. Ladders.

Things that stretch.—A football.

Things that bend.—Cart springs. Paper clips. Spider's web.

Machines.—Hoop, fly-wheel of sewing machine. Mangle. Waggon. Bicycle.

Movements. Swimming.

Musical Toys.—Musical Box. Drum.

(c.)

Water.—Syphon, pump. Oil, cream.

Solids.—Hinges, tires, and axles. The grindstone. Screws and screw-drivers.

Powders—Black lead.

Pastes.—Pottery.

Things porous.—Blotting paper, towels, wicks, earth.

Things that melt.—Lead, iron.

Water.—Salt lakes. Distillation of water. Clouds and rain.

Things that dissolve.—Crystals, hard water, varnishes.

Air.—The pop-gun, the fire-engine. Winds. A sailing ship.

Forms of Strength.—The roof. Railway bridges. Cranes.

Things that bend.—Clock spring. Chains.

Machines.—The loom. Threshing machine. Rolling iron rails. Coining.

Movements.—Flying.

Musical Toys.—Tin whistle. Sounds from stretched cord.

VII. MEASURING, WEIGHING AND TESTING.

A two-foot rule.

Measurements of length—first by eye, then with rule. Easy measurements of a square—first by eye, then with rule.	} Measurements in inches only.

Easy measurements of rectangles.

The wire-gauge.

Callipers.

Scales and weights.

Weighing of common objects—first by hand, then with scales; weight in ounces only.

Weighing letters.

Plumb-line.

Spirit-level.

Steam—observations on boiling water; condensation of steam, &c.

Mercury—weight of; *cf.* drop of mercury and drop of water; effect of heat on mercury.

Alcohol—effect of heat on it; its evaporation.

Thermometer—its manufacture.

Thermometer—uses; readings in ice, in boiling water, under the tongue, in schoolroom.

A candle—its composition. The wick.

Candle under bell-jar over water; candle in narrow-necked bottle.

Chalk—where found; its origin.

Chalk—its treatment with acid.

Chalk—its reduction to quicklime with blow-pipe; lime-water.

Sugar heated in test-tube; wood heated in test-tube.

Sulphur heated in test-tube; lead heated in test-tube.

Magnet and iron filings.

The compass.

AGRICULTURAL EDUCATION IN FRENCH RURAL SCHOOLS.

The following is an abstract of an interesting Memorandum issued by the French Minister of Education and reprinted in Appendix D. to the Blue Book [C. 8925, 1898] containing the Reports of the Commissioners on Manual and Practical Instruction in Primary Schools under the Board of Education in Ireland. The article is illustrated with copies of the original figures:—

In French Schools instruction in the elementary ideas of agriculture is now compulsory, and the scheme formulated here is intended as a general guide to the teachers, giving essential directions, with which they should comply, whilst adapting their courses to local circumstances and to the capabilities of their pupils.

DIRECTIONS TO TEACHERS.

"Instruction in the elementary principles of agriculture, such as can be properly included in the programme of primary schools, ought to be addressed less to the memory than to the intelligence of the children. It should be based on observation of the every day facts of rural life, and on a system of simple experiments appropriate to the resources of the school, and calculated to bring out clearly the fundamental scientific principles underlying the most important agricultural operations. Above all, the pupils of a rural school should be taught the reasons for these operations, and the explanation of the phenomena which accompany them, but *not* the details of methods of execution, still less a *résumé* of maxims, definitions or agricultural precepts. To know the essential conditions of the growth of cultivated plants, to understand the reasons for the work of ordinary cultivation, and for the rules of health for man and domestic animals—such are matters which should be

taught to every one who is to live by tilling the soil; and this can be done only by the experimental method.

The master whose teaching of agriculture consists only in making the pupils study and repeat an agricultural manual, is on the wrong path, however well designed the manual may be. It is necessary to rely on very simple experiments, and especially on observation.

As a matter of fact, it is only by putting before the children's eyes the phenomena to be observed, that they can be taught to observe, and that the principles which underlie the science of modern agriculture, can be instilled into their minds. It should be remembered that this can be done for the rural agriculturist only at school, where it will never be necessary to teach him the details which his father knows better than the teacher, and which he will be certain to learn from his own practical experience.

The work of the elementary school should be confined to preparing the child for an intelligent apprenticeship to the trade by which he is to live, to giving him a taste for his future occupation: with this in view, the teacher should never forget that the best way to make a workman like his work, is to make him understand it.

To sum up: The aim of elementary instruction in agriculture, is to initiate the bulk of our country children into that degree of elementary knowledge which is necessary to enable them to read a modern book on agriculture with profit, or to derive advantage from attending an agricultural conference; to inspire them with the love of country life, so that they may prefer it to that of towns and factories; and to convince them of the fact that agriculture, besides being the most independent of all means of livelihood, is also more remunerative than many other occupations, to those who practice it with industry, intelligence, and enlightenment."

To meet the great difficulty of time requirements, it is suggested that an agricultural tinge be often given to reading lessons, arithmetical exercises &c. Thus, poems of country life, simple problems dealing with the price of local produce, or feeding mixtures for stock &c., will be found of great assistance to the regular lessons in agriculture. The time allotted to physical and natural sciences is two or three hours per week.

The programme is divided into three stages:—

(1.) Elementary Course, for children between seven and nine years of age.

(2.) Middle Course, for children between nine and eleven years of age.

(3.) Higher Course, for children between eleven and thirteen years of age.

ELEMENTARY COURSE.

The instruction in this course is a continuation of that of the Infant School (*Ecole Maternelle*), the garden being drawn upon for subjects for object lessons in addition to the class room.

MIDDLE COURSE.

The minimum duration of this course is two years for each child. The first year is devoted to imparting the rudimentary ideas of general science, so that only in the second year does agricultural instruction, properly so called, begin, and, even then, only by means of reading lessons, object lessons and school walks.

FIRST YEAR OF THE MIDDLE COURSE.

First Half Year.

1. *The three states of matter.* Carry out simple experiments to induce observation and comparison of these three states, for example, demonstrate the material nature of air by such experiments as inverting a wine glass or funnel in water and either seeing the air escape in bubbles, or feeling its pressure; see figs. 1. and 2. Blow or breathe air into a bottle, transfer it to another bottle, measure it, &c., Prepare steam, condense it, *i.e.* distil water. Prepare oxygen, (fig. 5), and perform simple experiments on combustion, identifying the products. Demonstrate atmospheric pressure, and the elasticity of air.

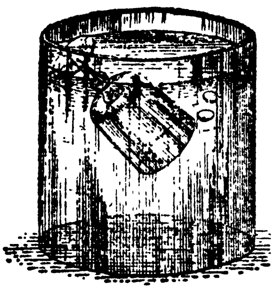

FIG. 1.

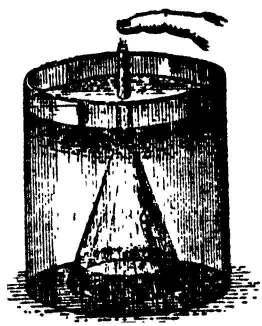

FIG. 2.

SIMPLE EXPERIMENTS ON GASES.

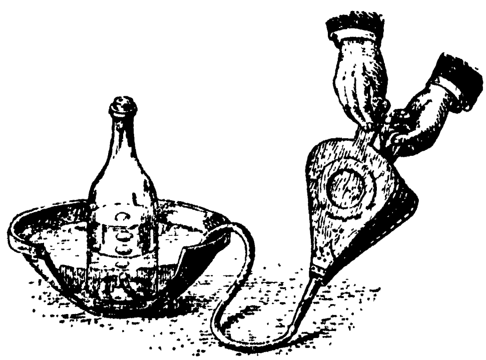

FIG. 3—COLLECTING AND MEASURING GAS.

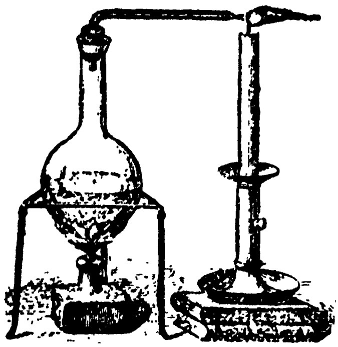

FIG. 4 —STEAM ACTING LIKE A GAS.

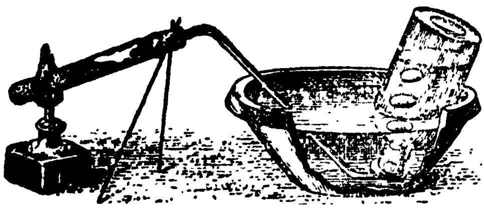

FIG. 5.—PREPARATION OF OXYGEN.

FIG. 6—PROOF THAT AIR CONTAINS ABOUT ONE-FIFTH OXYGEN.

2, *Animals.* Stimulate the children's curiosity by means of familiar conversations about common animals, selecting striking features in the life history of each. Amongst the subjects suggested are : a comparison of the different kinds of dogs ; comparison of the horse with the donkey ; the habits of the common fowl ; the periodic flights of swallows and other migratory birds ; life history of the frog, cockchafer, bee, silkworm, &c. Many of these will also serve for interesting reading lessons.

3. *Man.* Follow the lessons on animals by a description of the human body, and—only, however, after the experimental lessons of section (1)—an account of the functions of nourishment and respiration. Some advice on matters of health can well be given here.

Second Half Year. (Summer Season).

During this period plants furnish the best lessons, actual living specimens being brought under observation, either by bringing them into the schoolroom or by teacher and scholars going out of doors. No object lesson on plants should ever be given without the object itself being before the children's eyes.

1. *Plants.*—Draw the children's attention to some of the active phenomena of plant life, for example, germination. Beans, corn, &c., put into damp moss or sand easily furnish good specimens. An equally good method is to grow the plants in water, supporting the seed on a piece of cork. Fig. 7 illustrates such an experiment shewing the result obtainable in about one month.

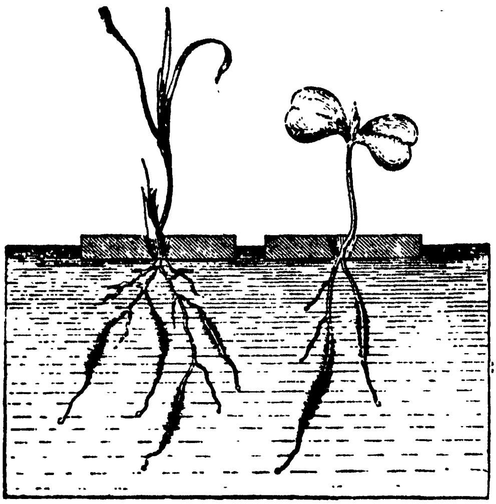

FIG. 7—CULTIVATION IN WATER.

Germination of a radish, and of oats; roots having root-caps and absorbing hairs.

Study, by means of actual specimens, leaf, branch, flower &c., carrying out such dissections as can be made with an ordinary penknife and pins. Choose examples which will give a general idea of the principal plant families which contain interesting, *i.e.* useful and noxious plants.

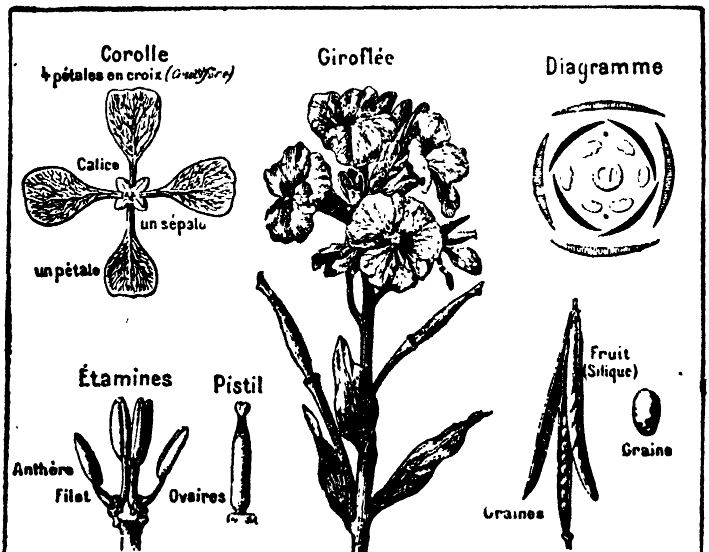

FIG. 8—ARRANGEMENT OF THE PUPIL'S WORK.

A good way of making these lessons profitable is to arrange the different portions of the flower studied on a sheet of paper

affixing them with a little gum, and to add to this natural representation a written explanation, and, if needful, a diagram. The figure given above is the exact reproduction of a page taken from the copy book of a child eleven years old.

2. *First Ideas of Agriculture.*—The children being yet under ten these must necessarily be very limited. Endeavour to attract the child and develop his powers of observation, and, at the same time to furnish him with a starting point for the more systematic lessons of succeeding years.

SECOND YEAR OF THE MIDDLE COURSE.

1. *Elementary Ideas of Science.* Extend the study of combustion to carbon dioxide. Demonstrate the presence of the gas in limestone. Prepare quicklime from chalk (an ordinary stove will provide sufficient heat) noting loss of weight during the operation. Shew the action of water on quicklime and demonstrate the properties of slaked lime, whitewash and lime-water. Prepare and collect carbon dioxide (Fig. 9), and re-obtain chalk.

Separate by washing a given quantity of soil (A) into clay (B), and limestone and silica (C). Treat (C) with hydrochloric acid, which, dissolving the limestone, leaves the silica (D), whilst the limestone (E) can be precipitated by sodium carbonate. The products can be kept, arranged on a board as shewn in Fig. 10.

FIG. 9—PREPARATION OF CARBONIC ACID GAS.

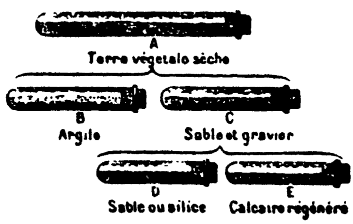

FIG. 10—COMPOSITION OF SOIL.

(Separation of the different minerals which form it).

2. *Elementary Ideas of Agriculture.* Investigate, particularly during school walks, the principal kinds of soils, and ordinary agricultural implements and operations. Demonstrate that plants, as well as animals, require nourishment in order to thrive; for example: grow beans,* some in good manured

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* The result obtained is still more striking if some small seed, *e.g.* buckwheat, etc., is used instead of beans, owing to the latter containing in themselves such a very large store of food material.—(Ed. W.I.B.)

soil, and others in sterile material such as exhausted soil, sand or broken glass, with and without manure.

FIG. 11.—PLANTS GROWN AS EXPERIMENTS IN STERILE MATERIAL.

A —Exhausted Soil without manure. B. Broken glass with manure.

HIGHER COURSE.

First Half Year.

1. *Animals.* Illustrate by means of common examples the principal distinctions used in the classification of animals, paying particular attention to the domestic animals, and, at the same time impressing upon the children the principles upon which the rules for the health and feeding of stock are based. Study the principal organs of the body, by observation of the dead animal.

2. *Man.* The teaching should be such as to convince them of the necessity of obeying the principal rules of hygiene, and should deal with digestion, circulation, respiration and the relation of the senses to the nervous system.

3. *Elementary Ideas of Physical Science.* Demonstrate by simple and inexpensive experiments, the principal effects of heat, light, electricity and gravitation. Accustom the children to the method of reading and understanding the indications furnished by the barometer and thermometer, and to the use of meteorological charts.

4. *Elementary Ideas of Chemistry.* Teach throughout experimentally, choosing experiments which have a direct bearing on agriculture, the substances which nourish plants being considered the most important. Fig. (12) shews the most complicated apparatus necessary for performing any of the following experiments:—Extraction of potash from wood-ashes; preparation of soluble phosphate from calcined bone; detection of ammonia in ammoniacal manurial compounds, &c., &c.

The pupils should learn to distinguish the principal artificial manures of commerce, the nitrates from compounds of ammonia and potash, the superphosphates from slag, &c.

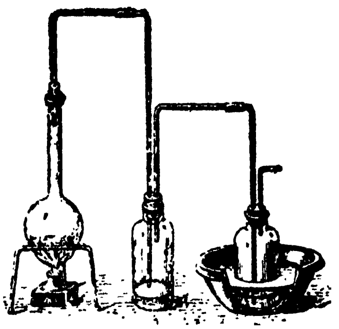


FIG. 12.—DISTILLING APPARATUS.
Preparation of Ammonia.

The really important thing is that the scientific terms which have become part of the current language of agriculture, should convey a clear and definite meaning to the children who are about to leave school.

5. *Minerals.*—By means of object lessons, chemical experiments and, still more important, school walks, study soils, rocks, kinds of land, &c.

6. *Agriculture and Horticulture.*— Make these lessons bear on local cultivation, and so arrange them that the lesson on agriculture or horticulture properly so called, shall be identical with the object of the last or the next walk, and with that of the practical exercise assigned for the same period.

Second Half Year.

1. *Experimental Cultivations.*—Plan and carry out these so as to demonstrate the following fundamental truths:—

(*a.*) The necessity for aeration of the soil.

(*b.*) The sufficiency of nitrogen, phosphoric acid, potash, and lime for the full development of cultivated plants.

(*c.*) The use of organic manure in improving the mechanical condition of the soil, in addition to its value as a plant food.

(*d.*) That manure is suitable to a soil which provides that substance which the particular soil lacks for the nourishment of the plant to be grown.

(*e.*) That the addition of one necessary constituent in excessive amount is always useless and costly, and may be injurious if another is present in insufficient quantity.

Many of these experiments can be carried out very simply either by water cultures, or by cultivation in pots, or preferably, wooden boxes. The following figures reproduced from photographs shew some of the simple arrangements in actual use which have given good results.

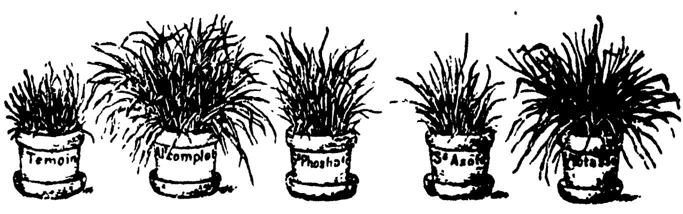
FIG. 13.—EXPERIMENTAL CULTIVATION IN WATER.

The solution contains the four substances furnished by soluble compounds, such as nitrate of potash and superphosphate of lime.

FIG. 14.—EFFECT PRODUCED BY THE ABSENCE OR INSUFFICIENCY OF ONE OF THE SUBSTANCES.

The two pots have been filled with sterile or exhausted earth mixed with superphosphate of lime and chloride of potash; when the corn was above ground, nitrate of soda was added to one of the pots, the other containing only a very small proportion of nitrate, the original quantity in the earth employed.

A. After Germination.



B. After partial Development.

c. At Maturity.

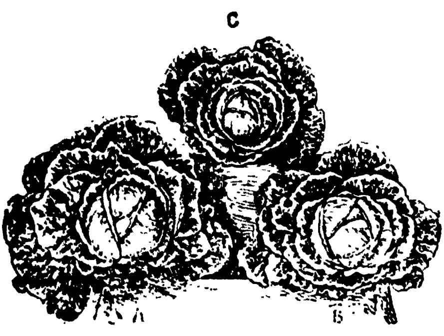
FIG. 15.—EXPERIMENTAL CULTIVATION IN STERILE OR EXHAUSTED SOIL.

The 1st is the standard without manure; the 2nd has received for each kilogramme* of soil, a manure formed of (*a*) 2 grammes of nitrate of soda, (*b*) 3 grammes of superphosphate of lime, and (*c*) 1 gramme of chloride of potash; the 3rd received (*a*) and (*c*): the 4th (*b*) and (*c*); the 5th (*a*) and (*b*). The 3rd produced more straw and less grain than the standard; therefore the manure was *injurious*; it was *useless* to the 4th.

Precautions necessary in pot cultivation. The pots should be made of porous earthenware, and, owing to the rapid evaporation, either stood in saucers of water, or buried in holes dug in the ground.

The soil in the pots should be covered with moss, finely chopped straw, &c., in order to prevent the hardening caused by constant watering.

Similar experiments should, if possible, be carried out in the garden. The result of one such experiment is shewn in Fig. 16.



Cabbages have been planted out in three ridges, A, B, C. A had farmyard manure; B had mineral manures as well as farmyard manure; C no manure. The figure represents one of the cabbages gathered on each of the three ridges.

FIG. 16.—ACTION OF THE DIFFERENT MANURES IN THE GARDEN.

* One Kilogramme=one thousand grammes=two and one-fifth lbs., Av.

Experiment to shew the fertilizing power of the liquid and gaseous products of farmyard manure.

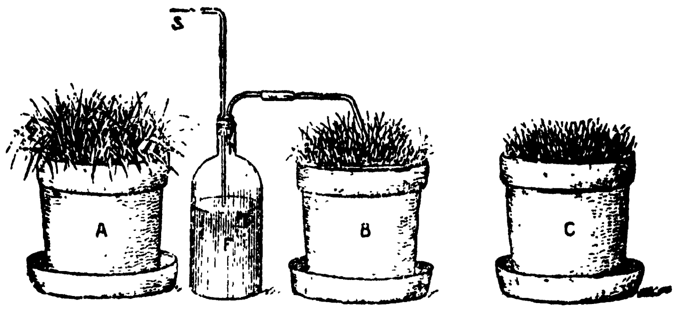


FIG. 17.

The three pots are sown with grass seed :—A. has received liquid manure B. gets the gas which comes from the manure in fermentation in the jar; C. has received nothing. The air in the jar F. is renewed by blowing into S. by means of an india-rubber tube or otherwise.

Experiment to shew the absorbing power of the soil.

FIG. 18.

The Soil in boxes (1) and (2) has been soaked with liquid manure; box (1) has then been abundantly watered by rain; box (3) has received nothing; it is the standard.

Note that owing to the absorbing power of the soil, the manure is not washed out of (1), this producing as good a crop as (2).

Great efforts should be made to impress upon the children the great waste of manure which takes place at present, amounting in France alone to the enormous value of nearly £20,000,000 annually.

2. *The Experiment Plot.*—Great care must be taken here to shew how a more remunerative yield can be obtained than

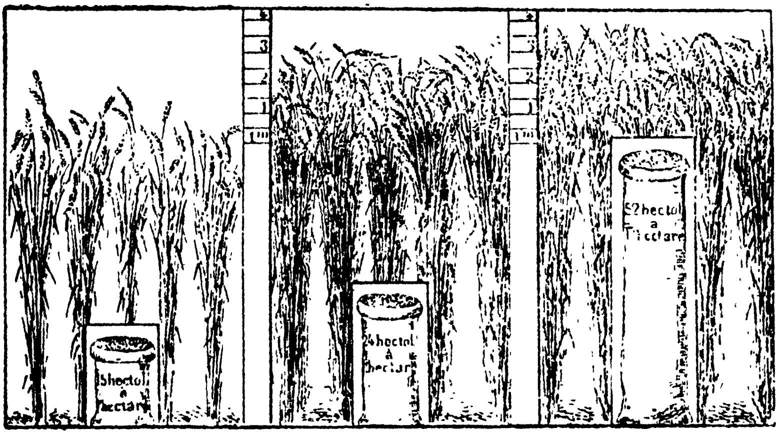
by ordinary methods. The use of excessive quantities of manure should be avoided, and the ordinary custom of the district taken as the standard of comparison.

In every experiment plot there should be :—

(a) The standard with no manure.

(b) With only farmyard manure, in the quantity usually added in the district.

(c) With the same quantity of farmyard manure, together with artificial manure in the proportion determined by the nature of the soil and that of the plant under cultivation.



NO. 1. NO. 2. NO. 3.

FIG. 19.—EXPERIMENT PLOT SOWN WITH WHEAT.

The manure given to No. 3 has been determined by the Professor of Agriculture from his knowledge of the soil.

In the cultivation of experiment plots the pupils should take part in the actual operations to an extent regulated by their capabilities, but their work *must be rational, requiring the exercise of the intellectual faculties as well as the labour of the hands.*

3. *School Walks.*—"These should be both preparatory and complementary to the class-room lessons on minerals, rocks, the principal kinds of soil in the neighbourhood, useful or injurious insects and plants, the essential operations of cultivation and the manipulation of agricultural implements, the distribution of manures, sowing, crops, &c.

The following is an indication of the principal subjects for study, of the nature of the observations to be made during school walks, and of the practical exercises common to both the Middle and Higher Courses :—

Ploughing.—How the different parts of the plough are placed; how the ridges are cut by the coulter and the ploughshare and turned back by the mould board, which is shaped like part of a furrow; the distance from the point of the coul-

ter to that of the plough-share, according to the stiffness of the soil. The method of lightening the soil, of ærating it, of manuring it, of utilizing the water of the sub-soil. How the depth of the ploughing is regulated. The season for ploughing and the number of times it should take place, in tilled and in fallow land.

Harrowing and Rolling.— How the teeth are placed in a harrow. The effects of the operation of the harrow and the roller on the soil—levelling and superficial pulverisation. The result as regards gravel or clay soil if rain supervenes—hardness produced and æration impeded. Action of the harrow on seed plots, on dog grass and other noxious weeds. The crushing of clods of earth by the roller: levelling with a view to facilitate mowing or reaping later on. The moulding up of winter cereals that have been exposed by frost. The season for harrowing and rolling.

Use of Manures.— Management and spreading of farmyard manure. The different kinds of manures. Their use before and after tillage. Manures used as top-dressing in tillage, in meadows, and in gardens; effects of farmyard manure in hot-beds for early vegetables or fruit.

Sowing.—The conditions necessary for germination; effect of the depth of the seed plot, and influence of the season. The quantity of seed.

Pruning and Grafting.—Pruning and grafting of fruit-trees, shrubs and vines. In vineyards infested with *Phylloxera*, practice in grafting vines should receive very particular attention.

Lighter operations of tillage.— Pressing the earth, development of adventitious roots; second tilling; destruction of weeds; æration of the superficial roots; the danger of the second tilling being too deep in the case of some plants, vines, &c.; weeding.

Cropping.—The succession of deep-rooted plants to those with superficial roots; nitrates found again in the sub-soil; green manures; fallow land.

Harvest.— Principal operations, management, preservation and valuation of the harvest reaped in the district.

The manipulation of mechanical implements, such as the horse-rake, the mowing machine, the reaper, the sower, the threshing machine, the sorter, the straw chopper, &c., will furnish, if occasion offers, subject matter for instructive explanations given by the teacher or by the man who uses these machines.

To sum up—Explanation of the work done by the agriculturist in his fields or in his vineyards, in his granary or in his cellar, in his stable or in his farmyard, should be necessarily based on observations from nature. They should give rise to lessons in the class room, before or after the school walk, and to written summaries, and to comments made, as a rule, during suitable reading lessons.

No doubt, the child, on leaving the elementary school, even after completing the normal period of school life, and having

attended regularly, will have acquired no more than what, from the point of view of the science of agriculture, are merely elementary ideas; but if the study of it has been made attractive and interesting to him, he will continue it as far as he finds means to do so.

As with all other instruction, so with that in agriculture, the work of schools must remain incomplete unless provision be made for its continuation and development."

FUMIGATION OF SEEDS AND PLANTS.

The following information respecting the methods in use for the fumigation of seeds and plants is published in continuation of the article which appeared in the *West Indian Bulletin* Vol. 1. pp. 309-325. There is added a memorandum by Mr. H. Maxwell-Lefroy drawing attention to the necessity for keeping under strict observation the imports, whether of fruits or plants, into West India Islands:—

EXTRACT FROM THE REPORT OF THE DIRECTOR OF THE ROYAL BOTANIC GARDENS, CEYLON, FOR 1899, PAGE 14.

Note by the Government Entomologist.

Quarantine experiments, in the form of fumigation of plants received in Wardian cases, have been attended with most satisfactory results. The hydrocyanic acid gas treatment has been employed. It has been ascertained that subjecting the plants to a high density of the gas for a comparatively short period is more effective than using a lower strength of gas for a longer period. For an ordinary Wardian case, with cubic contents (above soil level) of about ten feet, gas was generated from $\frac{3}{8}$ oz. cyanide, $\frac{3}{8}$ oz. sulphuric acid, and $\frac{3}{4}$ oz. water, and the plants kept under treatment for half an hour only, at the end of which time the case was thrown open. As a check on the experiments, sprays of plants with living *Orthezia* insects (lantana-bug) were included. In each case, the result was most satisfactory. Every insect was killed, and not even the most delicate plant was appreciably injured. *It is important that the treatment should be conducted after sunset*: 5.30 to 6 p.m. is the best time. On subsequently examining the plants treated (which had just arrived from England) two notable scale-insects—not yet established in Ceylon—were found viz., *Lecanium hesperidum* (the scale of the Orange tree), and *Pulvinaria floccifera* (an enemy of Camellia plants). Both these insects would probably flourish in this country, the former on Citrus trees of all sorts, the latter on Tea (a close ally of the Camellia.) Fortunately, the insects had been killed by

the treatment. The plants have since been under observation, but no fresh attack has occurred.

EXTRACT FROM THE REPORT OF THE GOVERNMENT ENTOMOLOGIST, CAPE OF GOOD HOPE, FOR THE YEAR 1899, pp. 6-9.

Import Regulations regarding Fruit, Trees, &c.

The restrictions on the importation of fruit, trees and other plants, bulbs, &c. to check the introduction of pernicious insects from abroad, remain the same as in 1896, with the addition of a Proclamation forbidding the importation of coffee plants. A copy of the regulations is published as Appendix B. The Natal Department of Agriculture has adopted regulations similar to ours.

The value of these regulations depends very largely upon the thoroughness with which the provisions are enforced, and much has been done during the past year to ensure thoroughness. At the first of the year, the inspections were left wholly to Customs officials; much more desirable arrangements have now been made. At Port Elizabeth, the Superintendent of the city parks, Mr. J. T. Butters, has been engaged as examining officer, and at East London the Curator of Queen's Park. It is believed that no better qualified parties than these two officers could have been found near the respective ports. At Cape Town the Surveyor of Customs, Mr. H. le Sueur, is examining officer, but under the existing arrangements the Assistant Entomologist acts with him in the examination of trees and plants.

Progress has also been made in the provision of facilities for the disinfection of plants and fruits found infested by insects. At Cape Town, fumigation with hydrocyanic acid has entirely superseded the far less reliable method of cleansing by use of soft soap washes. A fumigation chamber was erected near the Searcher's office during the latter part of 1896. The floor dimensions of this structure are about 10 by 20. Corrugated iron was used for the sides and roof. There are two compartments of equal size; the outer one is used for the storage of chemicals and other supplies, and the inner one, spoken of as the "chamber," for the fumigation. The walls of the chamber are of match boards covered with painted canvas and the door is made to close tightly against strips of felting. A flue containing a close-fitting valve leads from the roof of the chamber and provides for the escape of the gas before the chamber is opened after a fumigation. Supported on cleats, attached to the walls of the chamber are forty-eight removable wire-bottomed trays for the reception of fruit; each tray is capable of holding about 200 fruits in a single layer.

The fruit to be fumigated is placed on the trays, the flue is closed, the gas generated, and the door immediately closed. One ounce by weight of 98 per cent. potassium cyanide is used for each 150 cubic feet of enclosed space, and the gas liberated from this by the addition, in a lead vessel, of five fluid ounces of

sulphuric acid and ten fluid ounces of water. After the expiration of one hour, the flue is opened, and soon afterwards the door. Another half hour is allowed to elapse before the men enter to remove the trays. This treatment has been found to destroy scale insects and scale insect eggs even without the removal of wrapping papers, and that without any injury to the fruit. Chemical analyses by the Government Analyst have been made of fruits thus treated and the fact established, beyond any doubt, that all traces of the gas rapidly disappear and that *the treatment is in no wise detrimental to the public health.*

Trees and plants to be fumigated are laid on the trays or stood on the floor. The gas at the strength used has been found to have no injurious action on dormant deciduous trees, not even on young peach seedlings. This was proved in a series of experiments, the trees being planted after an hour's exposure to the fumes. Pear, apple and peach trees of different varieties were used in the experiment. Citrus trees appeared to be injured to some extent, but our results with these trees were too conflicting to allow of definite conclusions being drawn as to their liability to injury. The same density of gas has frequently been used for treating citrus trees in orchards without any noticeable damage resulting therefrom.

Being well satisfied with the success of the fumigation method of disinfecting insect-infested fruit and trees at Cape Town, the Department has approved of my recommendation that the same means be employed at East London and Port Elizabeth. I have selected suitable sites at these ports and submitted plans for the buildings ; in all likelihood these will be erected within the next few months. Our experience at Cape Town has shown us that larger buildings than the one in use there are desirable. The one I propose for Port Elizabeth is planned to cover a space 20 feet by 25 feet. It is to contain a fumigation chamber 10 feet by 12 feet, a store-room for supplies 8 feet by 10 feet, and packing-room 15 feet by 20 feet. The fumigation chamber arrangements will be much the same as in the Cape Town chamber, the chief difference being the substitution of a hinged window near the top of the back of the space as the means of ventilation in place of the roof flue. The structure for East London will vary little from the one designed for Port Elizabeth.

These fumigation chambers will accommodate from 9,500 to 12,500 fruits at a time. If the imports of fruit in the future justify the measure, an extra set of trays will be furnished, the second set to be filled with fruit while the other is in use inside the chamber. By the use of two sets of trays the process of fumigation may be conducted three or even four times in the course of a working day.

A storage building 20 feet by 42 feet, for the accommodation of fruit and trees awaiting fumigation is soon to be erected at the Cape Town Docks. For this structure, I have selected a site in the immediate proximity of the fumigation chamber. The fruit will be unpacked and placed on the trays in this building.

The insects discovered in consignments of trees and fruits during 1897 were almost identical with those found during the previous year, and enumerated in the last report. None but the Codlin Moth deserves special mention. This insect was present in a number of consignments of Madeira apples which arrived during our winter. It is one of the most destructive of fruit pests. The larva or caterpillar bores its way to the core of the fruit. As it is hardly reasonable to suppose that even hydrocyanic acid gas would penetrate the burrows, I recommended that all consignments of apples in which this insect was found should be confiscated and immediately destroyed. These recommendations were approved, and several hundred cases of fruit were burned as soon as landed. The option of immediately re-shipping the fruit on some Home or Australian bound vessel for consumption on the voyage was offered to the consignees of this fruit, but only in a few instances were any able to avail themselves of the privilege.

Simple as is the disinfection of fruit and plants by means of the fumigation method described, the expense to the consignee is considerable, and the restrictions are having the desired effect of causing the merchants to do their best to import only such articles coming under the regulations as are wholly free of insect infestation. This fact is sometimes well illustrated by the findings of the examining officers. On one occasion, an inspector reported that certain cases of fruit trees consigned from Europe for sale in this Colony were wholly free of injurious insects, while the trees in some other cases sent by the same consignor, and on the same vessel, but consigned to parties beyond the borders of the Colony, were found to be much infested. Evidently the consignor was not aware that we examine all consignments landed at our ports, although a previous disagreeable experience had taught him that we would not pass unclean stock for sale within our borders.

APPENDIX B.

Import Regulations.

Proclamation 107, 1086.

I. The importation into this Colony from places beyond the boundaries thereof, of all grape vines, or cuttings, or portion of grape vines, is absolutely prohibited, with the exception of vines or portions thereof imported by the Government of this Colony under such precautionary measures as it may decide to be necessary.

II. All trees and plants other than vines and all parts thereof, and all fruits of any description, and all the tubers, roots, bulbs, or portions thereof, and all packages, cases, pots or coverings whatsoever containing such, shall, before being introduced into this Colony from places beyond the boundaries thereof, undergo a strict examination by a competent officer appointed for that purpose, to determine, as far as possible, the absence of noxious insects and plant diseases which it would be pre-

judicial to this Colony to allow to be introduced; and it shall be the duty of the consignee to open all such packages, cases, or coverings for the purpose of the examination aforesaid, and to afford every facility to the said Examining Officer during his examination.

III. On the aforesaid Officer being satisfied as to the absence of noxious insects and plant diseases in such trees, plants, fruits, tubers, roots, bulbs, or portions thereof, and their packages, cases, pots, or coverings, he shall give a certificate to that effect to the consignee; and without such certificate no such articles shall be landed.

IV. All trees, plants, fruits, tubers, roots, bulbs or portions thereof, or the packages, cases, pots, or coverings in which they may be packed, which shall be found to be infected with any noxious insect or plant disease, shall be cleansed or disinfected by the consignee in the manner prescribed by and to the satisfaction of the Examining Officer; and if not so cleansed or disinfected, or if such disinfection shall be deemed or found to be ineffectual, shall be immediately destroyed.

V. The importation or introduction of any stone-fruit tree or any fruit, scion, cutting, graft, root or seed, the growth or produce thereof, from the United States of America or the Dominion of Canada, is hereby absolutely prohibited, and any one importing or introducing such fruit, tree, or other article, the growth or produce thereof, as aforesaid, shall upon conviction be subject to the penalty provided in the body of this Proclamation, and in addition thereto the fruit tree or other article imported shall forthwith be destroyed.

MEMORANDUM BY MR. H. MAXWELL-LEFROY, ENTOMOLOGIST TO THE IMPERIAL DEPARTMENT OF AGRICULTURE IN THE WEST INDIES.

The following cases, which have come under my observation, illustrate the danger of importing plants, fruits and vegetables without supervision or adequate measures to prevent the introduction of pests:—

1. *Pine apples*—I have observed specimens of a "Mealybug" (*Dactylopius*) on pine apple fruits brought into Barbados from a neighbouring Colony.

The genus *Dactylopius* includes some very destructive insects, which spread with rapidity, are difficult to exterminate, and live on a variety of plants.

2. *Oranges*—Orange fruits brought into Barbados are constantly infested with two insects: one a scale insect, *Mytilaspis citricola*, the other a mining insect. *Mytilaspis citricola* lives on the leaves, bark and fruit of *Citrus* trees, and is very destructive. The mining insect lives in the rind of the orange. I have not seen it in the oranges grown in this island.

3. *Yams*—Tubers of yams were received at this Office from the Curator of the Botanic Station, Grenada. They were densely covered with a scale insect, *Aspidiotus Hartii.* Mr. Hart says the insect does not materially injure the growing plant. Its presence on the tubers would in all probability deteriorate them and interfere with their sale.

4. *Mango*—No disease has been observed on imported fruits of mango. But young plants in transit on a Royal Mail Steamer were observed to be infested with *Vinsonia stellifera* the "glassy star scale." This scale insect is common on mango plants and attacks sapodilla, cocoanut palms, and many other cultivated plants.

5. *Sweet potatoes*—The sweet potato crops in Barbados are in some localities attacked by a weevil. It is not the same insect as attacks sweet potatoes in Jamaica. Infested tubers might, unknowingly, be sent to another Colony with sound tubers, and one such tuber might be sufficient to enable the pest to become established in the new locality. Once established, *it would be exceedingly difficult to check or destroy it.*

Of the above pests, four are scale insects. These are peculiarly easy to introduce into new localities with plants or fruits owing to their minuteness and power of rapid reproduction. They also seem to be the most dangerous class of pests at present occurring in the West Indies.

H. M-L.

Errata in the Present Volume.

Page 34, line 9 from top, *for* Dactylopieae *read* Dactylopiinae.
Page 34, line 10 from top, *for* caleolariae *read* calceolariae.
Page 34, line 13 from top, *for* Dilpliax *read* Delphax.
Page 411, line 23 from top, *for* gumifera *read* gummifera.

APPENDIX.

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INDEX.

C.

D.

E.

G.

H.

I.

J.

K.

L.

M.

N.

O.

P.

Q.

R.

S.

T.

U.

V.

W.

X.

Y.